12057

EDITORIAL

CALIFORNIA State Spiritualistic Association will meet in San Francisco on September 8. This seems somewhat late for the ghost to walk.

"CRUSHING cement is easier than crushing the Mexican revolution," says Huerta. He ought to know. The making of a durable material of construction is more useful than joining in the Mexican 'rough house.'

CONTRACTORS for municipal work in California should take heed of a recent decision handed down by the State Supreme Court to the effect that in cases where a street has been accepted as a public thoroughfare, the cost of further improvements cannot be assessed upon the abutting property.

PROTECTION to the California oilfields from infiltrating water is now assured. Governor Johnson has signed the Maddux bill and now interest in the matter centres about the selection of the oil and gas commissioner, who will be responsible for the success or failure of the measure.

CO-OPERATION between State and Nation with regard to the development of natural resources has been carried into effect with marked success in Oregon through the efforts of Mr. John H. Lewis, state engineer, and Mr. Franklin K. Lane, Secretary of the Interior. California is next in line, through the passage of an act by the last legislature with reference to the development of the so-called 'Iron Canyon Irrigation Project' on the upper Sacramento river. It is hoped that similar measures will be rapidly extended to all irrigation projects.

AUTOMOBILE taxes have been put upon a more rational basis through the adoption by the California state legislature of what is known as the A. L. A. M. method of calculating the indicated horse-power. A rate of 40 cents per indicated horse-power has been established, which is far more equitable than the former rule establishing a rate of taxation based upon the horse-power of the car in blocks of ten. On this basis an automobile of 20 horse-power paid the same tax as one of 29 horse-power, which resulted in protests that finally had their effect in the passage of the new ordinance.

PRICES for fuel oil in California continue on the downgrade. Following the commencement of the War and the immediate cessation of oil exports, the Standard Oil Company cut the price last October to 37½ cents per barrel for oil from 14° to 20.9° Baumé, and purchasing even at this figure was greatly restricted. Since that time sales have been made to other marketing companies by operators in dire need of cash at prices as low as 30 cents per barrel. Under these circumstances the announcement by the Standard Oil Company of a reduction in price to 32½ cents per barrel will have little or no effect upon present marketing conditions.

OPERATORS on oil land that was withdrawn in 1909 and who had not even prepared to commence drilling at the time the withdrawal order was issued, have admittedly been placed in a serious predicament by the decision in the Midwest Oil Company case. Two other classes of operators are also affected, namely those who had already located land and who on the fateful September 27, 1909, were making *bona fide* efforts to commence drilling, and those who at the same time had commenced drilling but on the day of withdrawal had temporarily suspended operations for any reason. The so-called McCutcheon case recently decided adversely to the claimants by the General Land Office falls in the latter class. From the standpoint of simple justice, however, it would appear that such operators should receive more consideration at the hands of the Government than has thus far been accorded them. A number of such operators in the Midway field have formed a defensive organization in order that by collective effort they may stand a better chance to obtain a hearing and a favorable verdict in the appeal of their case to Washington.

ANOTHER outpost has been captured by the triumphant army of the jitneys. The Tidewater & Southern Railroad operates between Stockton and Modesto. It was planned to extend the road from Modesto to Turlock, and the plans were well under way, to the delight of the stockholders and the railroad contractors. Enter Jitney. A few miles away, and approximately parallel to the right-of-way for the proposed extension, is the new State highway. The result was obvious. Reluctant to abandon its plans, the railroad company suggested an ordinance to the supervisors of Stanislaus county, calling attention to the total irresponsibility of the jitney operators and suggesting that in the interests of the traveling public an ordinance should be passed providing that the operators carry accident liability insurance and pay in to the treasurer of the county a percentage of their gross receipts to be added to the road maintenance fund. However, this ordinance was defeated and the company in consequence abandoned all plans for the construction of the extension of the line. The transportation companies, especially those who depend largely upon local passenger traffic, may thus read the handwriting on the

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wall and recognize and appreciate the existence of their new double enemy, good roads and gasoline.

Sale of Los Angeles Municipal Cement Plant

There is a story that passes current among those addicted to such tales about the troubles of the man who had an elephant on his hands. This leads up to the subject of the cement plant owned by the city of Los Angeles and built for the purpose of supplying cement for the construction of the Los Angeles aqueduct. This plant has been the storm centre for much of the criticism leveled at the aqueduct construction. Since completion of the aqueduct, many attempts have been made by the city officials to dispose of the elephant, but commercial interests have fought shy of it, not that the equipment was in any way defective, but that the material available for cement manufacture was, to say the least, questionable in quality. Portland cement, like Caesar's wife, should be above suspicion, as the security of life and limb, as well as the economic features entering into engineering construction depend largely upon the quality of the cement used. Nevertheless the city officials felt it their duty to salvage what they could from an investment of something over $500,000 and continued their search for someone upon whom the plant might be unloaded. A willing victim has been found in the form of Los Angeles county itself, a lease having been consummated whereby the county is to pay to the city an annual rental of $27,500 for a period of three years. A further provision in the lease stipulates that at the end of the first year, the city may offer the plant for sale and the county agrees to bid $550,000. The city is to have the privilege of buying cement in any quantity desired for its own needs at a price of $1.35 per barrel; is to receive a royalty of $5\frac{5}{8}$ cents per barrel on all cement manufactured, and is to receive a depreciation allowance of $11,000 per annum, this latter amount to be returned by the city in the event of a sale of the plant.

The city officials are pleased, naturally. Probably the county officials are also pleased, although the reasons why are not so clear. We have no indication as to the feeling of the taxpayers, but would be interested to learn whether they are deluding themselves as to the probable outcome. They will in the first place have to pay to maintain the cement plant in the form of county instead of city taxes. In the second place, they will have the additional pleasure of being taxed for tufa instead of portland cement streets and sidewalks and other municipal improvements, thereby lowering the first cost a little, and increasing the maintenance cost a great deal.

That the county of Los Angeles proposes to go into the 'cement' business in real earnest is shown by their bidding upon a lot of 90,000 barrels of cement recently in the market for the construction of the Kern County highways. Fortunately for Kern county, however, the order was placed with a manufacturer of established standing.

Permanent Highways and County Politics

Someone once said of a man that he was astonishingly well informed concerning things that were not so. This, unfortunately seems to have been the state of mind of voters of Kings county, California, who recently authorized a bond issue for $102\frac{3}{4}$ miles of road at a first cost of $672,500. The use of the word 'first' as applied to cost in this case is made advisedly, as the course pursued by the majority of voters would indicate that they were not informed as to the difference between first cost and last cost. It seems indeed unfortunate that in this enlightened age such fundamental factors as the character of the sub-grade and probable life of the surface should apparently have been neglected in deciding upon the type of pavement adopted. Nevertheless, this seems to have been the case in Kings County highway improvement project, at least it would appear so on the surface, although it is more than likely that quite another consideration was the actual determining factor.

The selection of routes for such municipal improvements, as streets, sidewalks, and roads, is in most cases influenced by political exigencies rather than economic factors. Consequently, in many cases a sum of money sufficient to build 75 miles of genuine good road is stretched beyond the elastic limit in order to build 100 miles of road that is at best only a compromise. This, then, is one of the many fundamental reasons for the high tax rate in so many American municipalities, both large and small. Short-sighted and misinformed electors have gone blithely to the polls and voted for the issuance of twenty-year bonds for the construction of improvements which on the face of the specifications could hardly be expected to last more than four or five years at the utmost before large sums of money must be expended for maintenance, upkeep, and repairs.

As to what constitutes a good road, there is little, if any, room for a radical division of opinion. Hundreds of millions of dollars have been expended for this purpose within the United States during the last five or six years, or since the advent of the automobile in large numbers made good roads a live issue in every village and hamlet in the country. The results obtained through the use of many types of road surfaces are no secret; they have been published time and time again in the columns of the technical press and in official reports issued by the various city, county, and state highway commissions. There can be no excuse for making a mistake in this respect through the absence of exact information as to the results that may be expected from any type of construction, whatever it may be. If the voters could only realize it, they would be far better off individually and collectively to install one mile of good road that will be as nearly permanent as modern science and knowledge of the subject permits, than two miles of road that will practically have to be rebuilt many years before the maturity of the bonds sold to pay for it. This is true even if the road does not pass the front door of every voter in the county.

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REVIEW OF THE MONTH

SAN FRANCISCO has become the Mecca for practically all of the scientific and technical societies under the sun. The most notable of the many conventions that have taken place thus far, has been the meeting of the National Electric Light Association during the past month. Many excellent papers were read at the different sessions and a few of those of more general interest have been reprinted or abstracted in this issue.

THE constructive value of such organizations as the National Electric Light Association can hardly be minimized. Semi-commercial and semi-technical in its character, the investigation work alone undertaken by the various sub-committees throws additional light upon the economic as well as the technical phases of the subject, all tending toward the realization of a higher efficiency and an increased value in public service.

REORGANIZATION of the affairs of the Western Pacific Railroad is well under way. A committee has been formed to work out plans for submission to the holders of the first mortgage bonds. Negotiations have commenced with the Denver & Rio Grande Railroad toward a settlement of the relations between the two roads. In this direction, however, little progress has been made and all signs point to the possibility that a suit may be instituted to force the latter company to make good its guarantee of the Western Pacific bonds. Should this action be taken and prove successful, it is not unlikely that it would force the Denver & Rio Grande Railroad into a receivership also. In any event, the position of stockholders is far from promising. Nevertheless, if steps may be taken to tide over existing dullness in business conditions generally, the development of the West that will undoubtedly take place within the next twenty years will do the rest. Incidentally, it should not be forgotten that some fifteen or twenty years ago the financial condition of both the Santa Fé and the Union Pacific Railroads was not much better than that of the Western Pacific today. The Santa Fé company in its report for the ten days ended April 30 showed an increase in its gross revenue of $5,000,000 and in its net revenue of $3,000,000 as compared to the corresponding period a year ago.

WHATEVER allegations may have been made by the muck-raking fraternity as to the unholy alliances said to have existed in the past between the railroads and the courts, we do not believe that even a hint of anything of the sort can be truthfully made nowadays. For example, the United States District Court has handed down the expected decision canceling the patents held by the Southern Pacific Company to 6400 acres of oil lands situated in the Elk hills, Kern county, California. These lands comprise the odd numbered sections, patents for which were issued in 1904 under the original Federal land grant to the railroad company. At this time producing wells were in existence a few miles away and in 1910 during the Midway boom a number of wells were drilled on adjoining lands. In the same year the Government brought suit against the Company to cancel the patents to the land in this district on the ground that they were mineral bearing. Curiously enough, the most conclusive proof of the contention of the Government was furnished by the Associated Oil Company, which is a Southern Pacific subsidiary, and which was the only operating oil company that obtained oil in the Elk hills in any appreciable amount. The Associated Oil Company's wells were shut down soon after their completion, but it is not unlikely that the Government's suit, together with the withdrawal order, were the Gold Dust twins that did the work. It is presumed that the case will be appealed, but there seems to be little ground for the expectation of a reversal. In another case involving the oil lands held by the Southern Pacific Company near Coalinga, California, the company had asked in a demurrer that the suits be dismissed by reason of the statute of limitations. Judge B. F. Bledsoe has overruled the objection and the case will now go to trial. In view of the decision in the Elk Hills case, it is extremely unlikely that the railroad will be able to retain this land.

FOLLOWING the decision of the court divorcing the Southern Pacific Company from its oil land holdings in the Elk Hills district has come the decision of the Interstate Commission lopping off another tentacle of the so-called octopus. This latest operation has taken the form of an order directing the Associated Oil Company, a Southern Pacific subsidiary, to discontinue the operation of oil tank-steamers between California and points in Oregon and Washington. This order, if carried into effect, will be a severe blow to the operations of the Associated company. It is likely that the usual expedient of organizing a holding company to operate the steamers will be employed. Whether this will be permitted by the Federal authorities is another question. The next step in the unscrambling process is likely to be an order directing the Southern Pacific to dispose of its holdings in the Associated Oil Company. It is possible that a general segregation of its holdings would in the end be of advantage to the Southern Pacific Company. In the meantime, what is happening may be likened to the benevolent process of cutting off a dog's tail by inches.

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READJUSTMENT of industrial conditions brought about by the War is taking place with kaleidoscopic rapidity. Commodities made abroad no longer find their way across the water, and thus has brought about either a development of substitutes or the establishment of similar industries in America. Given a demand and the supply will be forthcoming has been proved time and time again. One of the most recent and at the same time interesting exemplifications of this familiar truism may be found in the situation brought about by the phenomenal rise in the prices of base metals. On the authority of the *Mining and Scientific Press* it may be stated that the price of zinc per pound on July 3, 1914, was 4.75 cents; on October 14, 4.55 cents, and on June 14, 1915, 26 cents. This condition, at first blush might be taken to indicate prosperity to the nth degree. And so it is, for the metal broker, the fortunate possessor of this valuable metal and the miners thereof. But how about those engaged in the various industries for which zinc is essential? This is another story. As a concrete example, take galvanized sheets. The present price of zinc is not only so high as to make the cost of this staple article practically prohibitive, but the agents for the various warring nations are so active in grabbing every pound available that the majority of manufacturers can see the time not far distant when they will not be able to obtain zinc at any price. Therefore, industrial America confronts the possibility of the shutting down of manufactories for which zinc is all or an essential part of the material required. This, then is prosperity of an extremely doubtful nature.

On the other hand, an opportunity is presented for what we are pleased to call 'Yankee' ingenuity. What can be used in place of zinc, especially as a resistant to corrosion, in short, what may be substituted for the galvanized products of commerce?

THIS question is now receiving most serious consideration at the hands of American manufacturers. One prominent maker of galvanized sheets and other products has already come out with an announcement of the perfection of a paint composed of red lead and linseed oil, which is applied to sheets that have previously been coated with a lead alloy as a substitute for zinc. This method, if proved effective, will permit a heavier gauge of plate to be used, as it can be furnished at a lower price than heretofore was charged for the galvanized product. Under these circumstances it does not seem unfair to assume that the life of a culvert, or roof, for instance will be approximately as long as was formerly given by similar galvanized sheets, especially if a second coat of the paint is applied at the time of installation on the job. It would also seem more than probable that an increased use will be developed for California asphalt products as a corrosion resistant. This use is of course an old one, dipped water-pipe and asphalt-coated tanks having been in use for many years. The pipe-line now under construction for the Shell Company to carry petroleum from Coalinga to the company's refinery near Port Costa is being coated with an asphaltic enamel that is said to be not only an effective rust preventive, but also to be proof against expansion and contraction and free from the brittleness that results in scaling of the coating when dry. It is to be hoped that California manufacturers of asphalt products will awaken to the opportunities afforded by this extraordinary set of conditions. The possibility of creating new uses for asphaltum seems almost without limit, and it is at least within the bounds of reason that when conditions again become normal, zinc as a preventive of corrosion will have been superseded by something better and cheaper. Whether or not this substance will be an asphalt product may depend upon the manufacturers.

THE value of the transcontinental telephone line for hurried communication was recently illustrated in connection with the annual convention of the American Institute of Electrical Engineers at Deer Park, Maryland. Three papers read and discussed at the forenoon session on June 29, by Messrs. Frederick Bedell and F. M. Mizushi were devoted to the subject of alternating current wave shapes, distortion factors, harmonics, etc. This subject, important in inductive interference between power and telephone lines, has been extensively studied by the joint committee on Inductive Interference appointed by the California State Railroad Commission. Its importance in this respect was not brought out in the papers themselves. The Joint Committee felt that it should contribute to the discussion, but owing to late receipt of advance copies of the papers, and to the absence of several members from San Francisco the matter could not be taken up actively until the morning of June 28. The American Telephone & Telegraph Company offered the use of its transcontinental line for the discussion of this subject if desired, and thereby made it possible for the Joint Committee to put its contribution directly before the convention, instead of in the form of a written contribution to the Proceedings. In the afternoon of June 28 the transcontinental telephone circuit was used by Messrs. J. E. Woodbridge and L. P. Ferris at San Francisco, talking with Messrs. H. S. Warren and H. S. Osborne at New York, to make arrangements for the transmission of the contribution. During the night of June 28 the Joint Committee's contribution of approximately three thousand words was forwarded by telegraph over the lines of the Pacific Telephone & Telegraph Company and the American Telephone & Telegraph Company through Pittsburgh to Deer Park, and the contribution was read at the session of the subsequent forenoon. Owing to peculiar weather conditions at one point in the long line, telegraphic transmission for a time was exceedingly difficult and threatened to become impossible. The Eastern officials were ready with stenographers to take the message by telephone if necessary, but about midnight conditions changed for the better and the message was completed. This incident is a striking example of a practical use in a large way, of one of the engineering feats of this century.

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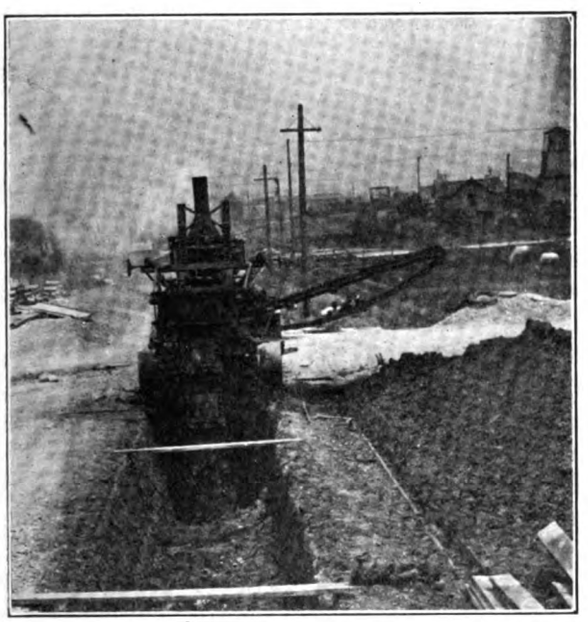
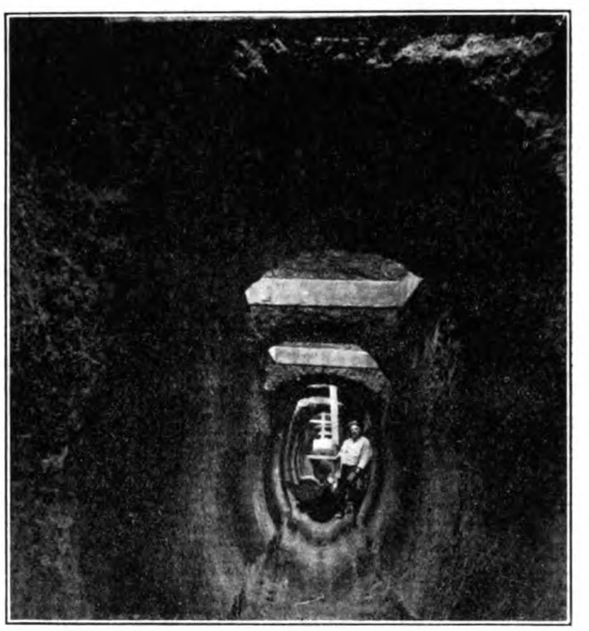
The Berkeley Sewer System—Part I*

The topography of the city of Berkeley and its vicinity gives to the problem of the disposal of storm water some unusual features. The western boundary of the city coincides with the shore of San Francisco bay. From the shore east, the slope is light for some distance, but increases steadily to 3% or more at the easterly city limits. Beyond the built up portion of the city, the ground rises abruptly to the summit of rolling hills about a mile away.

The natural drainage system of the territory comprises three important creeks; namely, Derby, Strawberry, and Lincoln. Temescal creek near the southerly boundary of the city flows through the city of Oakland for most of its course, and was not considered in planning the system. Codornices creek forms the northerly boundary of the city for a considerable distance, but its drainage area is not yet sufficiently built up to necessitate its being considered in the discussion of the storm-water problem.



EXCAVATOR DEPOSITING MATERIAL AT SIDE OF TRENCH.



LARGE SEWER JUST AFTER LAYING INVERT.

The western or lower part of the city was built up more rapidly in earlier years than the other portions, the great development of the latter coming after the San Francisco fire in 1906. The earlier sewers were, as a rule, constructed in a haphazard manner. They were usually small, six or eight inches at the outfall, and were constructed on any grade that would give the minimum amount of trenching. As the territory to the east was built up, connections were made to the existing sewers with small regard to the possibility of overloading their capacity. Thus, in one case two twelve-inch sewers near the University campus emptied into a ten inch main, and that in turn into an eight inch and then into a six inch, in spite of the fact that the grade was growing flatter at the same time.

As a result of this condition, it was not uncommon for even a slight storm to overtax the mains and cause sewage to back up and spout through manholes. This was particularly the case in the region west of San Pablo avenue. Another objectionable feature of the conditions then existing was that the sewers discharged either directly on the Bay shore or into the rather stagnant sloughs which form the lower portions of the various creeks flowing through the city, in either case resulting in unsanitary and offensive conditions at the outfalls. These conditions were aggravated by the fact that several manufacturing establishments near the shore discharge putrefying trade wastes.

The first study of the storm-water problem with a view to improvement of conditions was made in 1911. The original plan was simply to relieve conditions west of San Pablo avenue, but the rapid development in the eastern part of the city with the resulting increase in runoff, caused a change in plans, as it was seen that any plan which did not provide for the needs of the entire city would be simply a makeshift. It was then decided to construct a comprehensive system for the entire city of such a character that future increase of population would merely require additions to the system and not its reconstruction.

The question of combined as against separate sewers was next to be considered. It was recognized that cul-

*From data furnished by J. J. Jessup, city engineer of Berkeley, and members of his staff.

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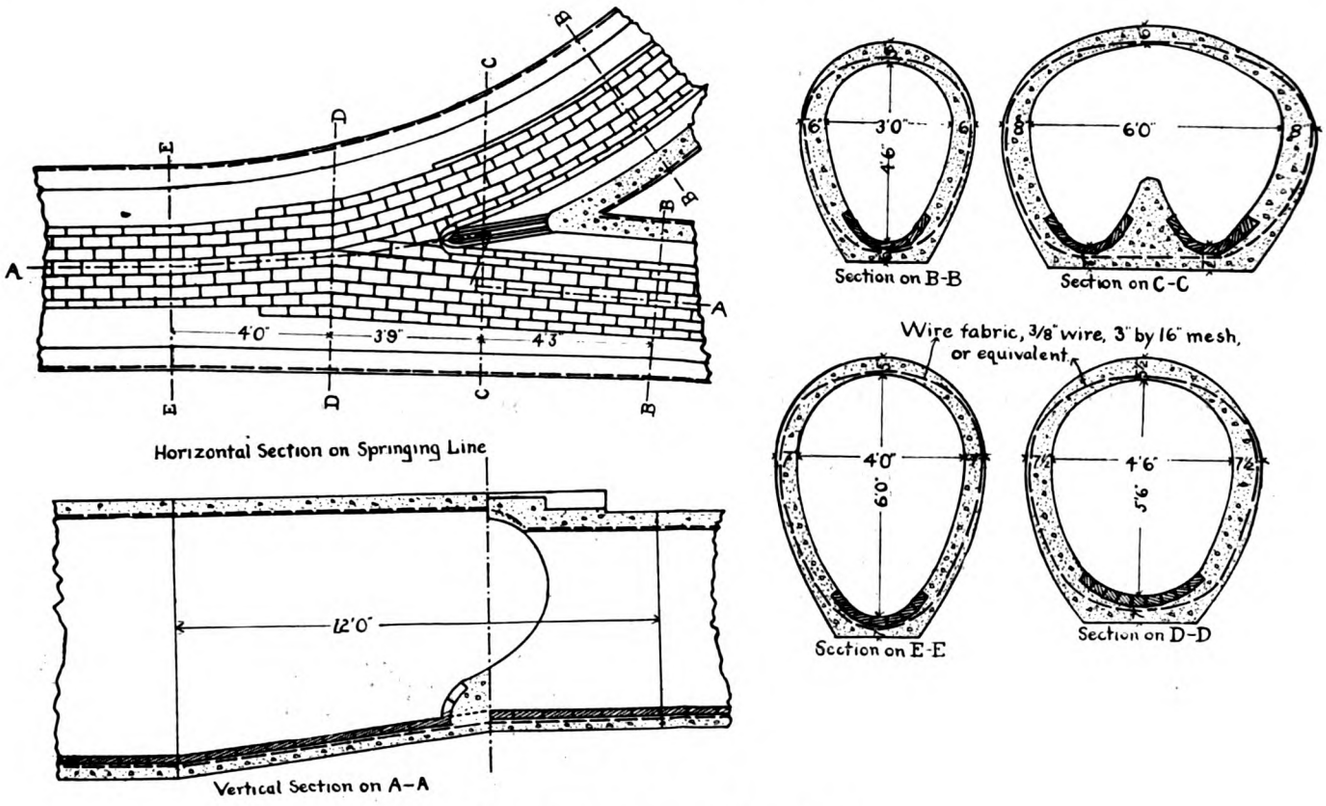

FIG. 1. DESIGN OF JUNCTION CHAMBER.

verts would be necessary across the main creeks on most of the city streets in case a separate system was decided upon. The volume of the waters of San Francisco bay is so great in comparison with the amount of sewage discharged into it that the possibility of sewage treatment being required at some future time was considered remote. For these reasons a combined system was decided upon, as covering the needs as well for all practical purposes at a somewhat lower cost than a separate system.

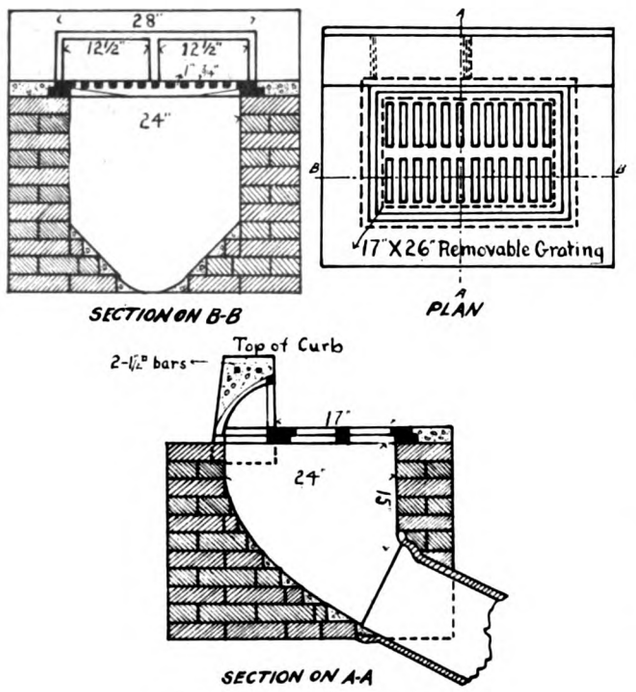

FIG. 2. STANDARD CATCH-BASIN.

The rainfall records kept by the University of California, as well as gaugings of Strawberry creek where it crosses the campus, both extending over a number of years, were of great assistance in computing the probable maximum storm-flow. The creek gaugings were particularly valuable in computing the proportion of runoff to be allowed for in the hill area to the east of the city. This was calculated to be 10%, but for safety was taken as 20% in figuring the storm-flow. For lawns and similar cultivated area within the city 20% was used. All streets were assumed to be oiled and a factor of 85% was used. As the unimproved streets have undoubtedly a much lower runoff than that figure, the assumption is on the side of safety. The average runoff for the residence districts as computed, varied from 52 to 70%.

Actual velocities were determined by taking the mean of float observations in gutters, and these velocities were used in determining the time of concentration at a given point, adding three minutes to all computed times to allow for the time consumed in flowing from house-roofs to the gutter. To determine the maximum flow to be carried by a given sewer, the tributary area was divided into sub-areas, and the flow from each sub-area computed. It was found that the maximum contribution to the sewer from each sub-area for the theoretical heaviest storm, did not as a rule come at the same time after the beginning of the storm. Be-

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cause of this fact, the following method of computation was used. The flow from each sub-area was computed for several minutes on each side of the computed maximum. The results were tabulated and added and the maximum for any one time considered as the maximum flow to be considered.

The following table of arbitrary quantities will illustrate the method used. Quantities in cubic feet per second.

Sub-area.	10 min.	11 min.	12 min.	13 min.
A	13	15	16	17
B	17	18	17	16
C	18	19	18	17
D	11	13	12	10
E	8	9	9	8
Total	67	74	72	68

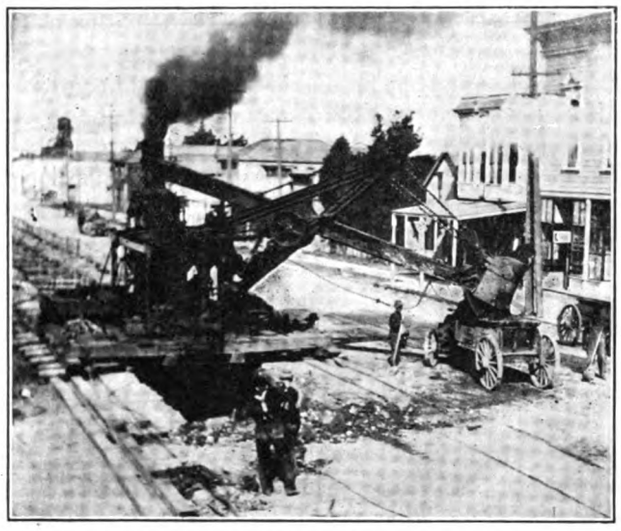
As the maximum discharge at any one time is thus determined to be 74 cu. ft. per second, the sewer would be designed for that amount.

With the exception of a few of the smaller mains,

DEPOSITING CONCRETE IN TRENCH.

which were circular, all of the sewers were egg-shaped. Figs. 1 and 2 show the general design. Kutter's formula was used in computing the sizes, n being taken as 0.012. Some of the computed velocities were as high as eighteen feet per second, for sewers flowing full.

In the design of the system, the sewer-arch was figured for dry weather conditions and the walls for saturated ground, such assumptions being on the side of safety. In calling for bids, alternate figures were requested; first, using steel bars for reinforcement



STEAM-SHOVEL DEPOSITING MATERIAL IN WAGONS.

with a unit stress of 16,000 lb. per square inch, and second, using Clinton cold drawn fabric and a unit stress of 20,000 lb. To avoid the deleterious action of sewage on concrete, the inverts of all sewers were lined with vitrified material, except in the outfalls where the sewers would be cleansed by the tide. Sewers three and one half feet in diameter or larger were lined with brick, having a maximum absorption of 2% of water in

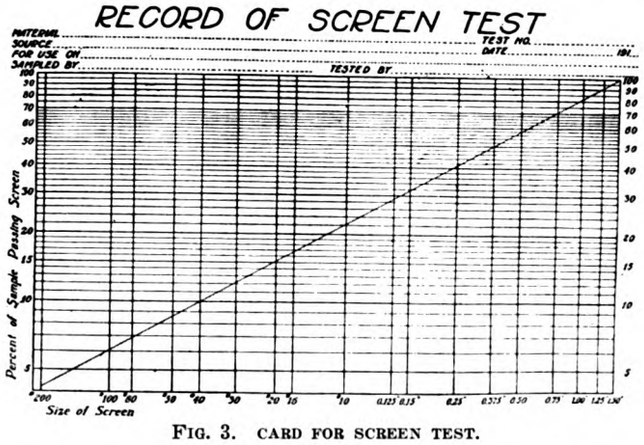


FIG. 3. CARD FOR SCREEN TEST.

72 hours. For smaller sizes, a special vitrified tile was used. As the ground was everywhere favorable and solid the trenches could be excavated close to the sewer section in size.

For the concrete a 1:2:4 mixture was the standard. Screen tests were made of all aggregates. A card such as is shown in Fig. 3 was used for plotting the results of the tests. On these cards, the ordinates and abscissae are plotted to such a scale that the curve of maximum density becomes a straight line. Such a line is shown on the card and any line parallel to it will also give the

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maximum density for a certain combination of aggregates. With the results of the tests of various aggregates plotted on these cards, it is a much easier matter to determine the proper proportion of aggregates than when the tests are plotted on ordinary cross-section paper. In some cases, as many as four kinds of aggregate were used in a mixture in order to give the best results as regards density.

The system as finally designed is shown on the map, Fig. 4. In general the three main outfalls with their three tributaries cover the three main natural drainage areas of the city, and correspond to the creeks mentioned

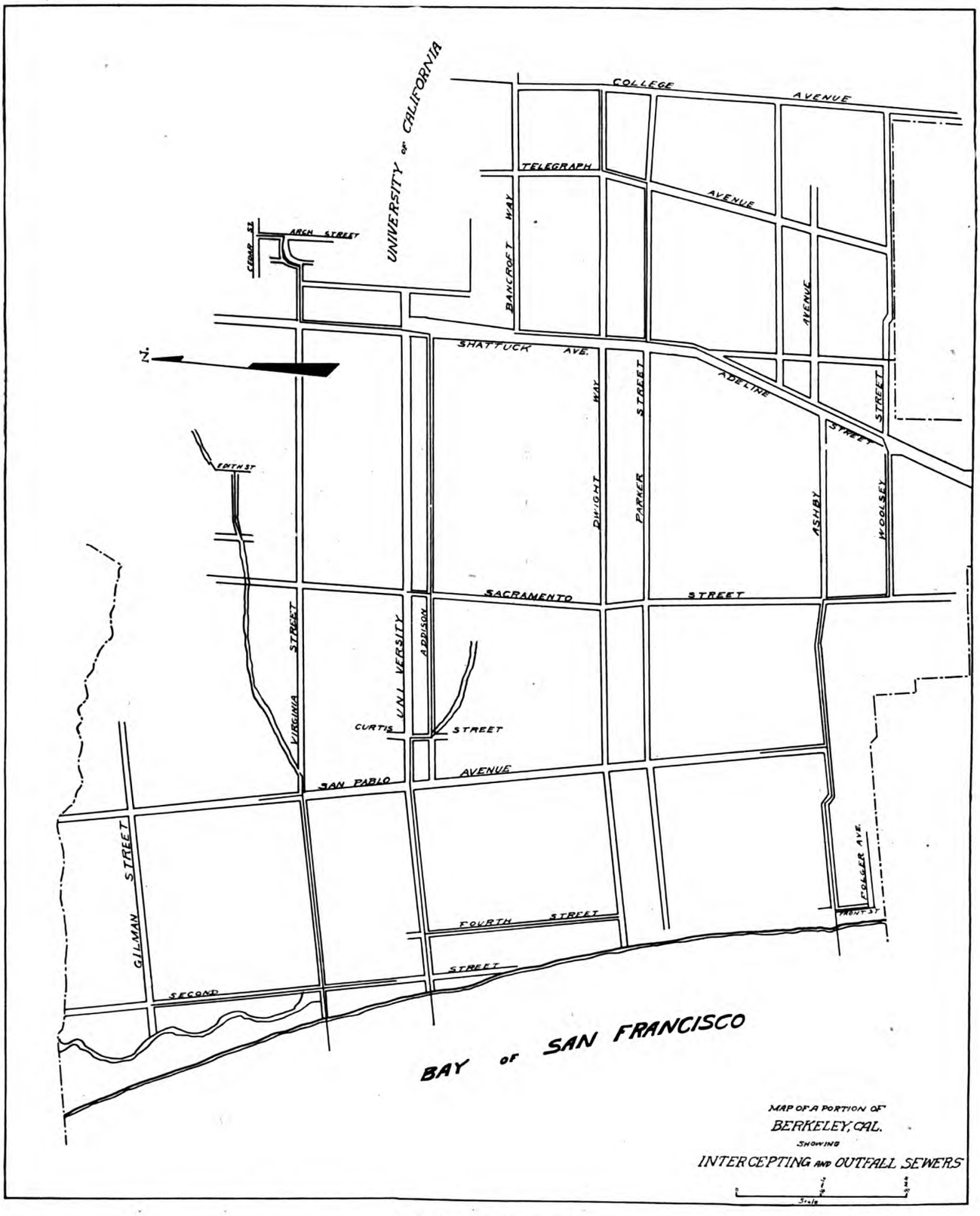

FIG. 4. MAP OF SYSTEM.

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at the beginning of the article. The outfalls discharge into San Francisco bay at points 600 ft. from the shore. It was decided that this distance would be sufficient to obviate the danger of fly-borne infection, the authorities agreeing that this is approximately the maximum distance that a house-fly will travel.

The total cost of the system was about $500,000. Work was commenced early in the spring of 1914, and was divided into thirteen contracts as follows.

No. 1. Trunk sewer diverting Lincoln creek between Vine and California streets, awarded to C. B. Burnham. Size, 30 inches.

No. 2. Trunk sewer carrying Lincoln creek drainage from Kains avenue along Virginia street to outfall, awarded to T. J. Shea. Size, 4 ft. by 6 ft. and 7 ft. by 8 feet.

No. 3. Trunk sewer carrying Strawberry creek drainage along University avenue from Curtis street to outfall, awarded to E. T. Thurston & Company. Size, from 5 ft. 2 in. by 7 ft. 9 in. up to 8 ft. 6 in. by 9 feet.

No. 4. Trunk sewer along Ashby avenue from Sacramento street to the outfall including small intercepting branches on San Pablo avenue and on Front street, awarded to Wm. Heafey. Size of the main sewer, 6 ft. by 9 ft. and 7 ft. by 9 feet.

No. 5. Trunk sewer along Woolsey street from Adeline to Sacramento and along Sacramento to Ashby avenue, awarded to Contra Costa Construction Company. Size, 4 ft. 8 in. by 7 ft. and 5 ft. by 7 feet.

No. 6. Trunk and intercepting sewer along Adeline street from Derby to Woolsey, awarded to Contra Costa Construction Company. Size, 4 ft. 4 in. by 6 ft. 6 in. and 4 ft. 6 in. by 6 ft. 9 inches.

No. 7. Trunk and intercepting sewer along Shattuck avenue from Bancroft to Derby streets, awarded to R. C. Storrie & Company. Size 2 ft. 6 in. by 3 ft. 9 in. to 4 ft. by 6 feet.

No. 8. Trunk sewer from College to Shattuck avenues along Dwight and Parker streets, awarded to M. Heafey. Size, 2 ft. by 3 ft. and 3 ft. by 4 ft. 6 inches.

No. 9. Trunk sewer along Addison street from Shattuck avenue to Curtis street, awarded to R. Ehrhardt. Size, 3 ft. 6 in. by 5 ft. 3 in. and 4 ft. by 5 feet.

No. 10. Trunk and intercepting sewer from Arch and Cedar streets to Shattuck avenue and Addison street, awarded to H. E. Franks. Size, 2 ft. by 3 ft. and 3 ft. by 4 ft. 6 inches.

No. 11. Short intercepting sewer along San Pablo avenue from University avenue, north, awarded to Gorrill and Touhy. Size, 2 ft. by 3 feet.

No. 12. Intercepting sewer along Fourth street from Dwight way to University avenue, awarded to W. J. Schmidt. Size, 15 inches and 18 inches.

No. 13. Intercepting sewers on Second street from Gilman to Virginia and from Bristol to Virginia, awarded to P. Schuyler. Size, 12 inches and 24 inches.

Most of the contracts were completed during the fall, and the entire system was in working order before the heavy storms commenced. While several were accompanied by heavy rainfall, no trouble was experienced.

OILING ROADS TO PREVENT DUST

The use of asphaltic oils to prevent or reduce dust on ordinary roads, in distinction to their use in constructing oiled-macadam and similar pavements is discussed by T. R. Agg, of the University of Iowa in a recent number of *Oildom*. Oils containing from 40 to 50% of so-called 'asphalt' are the best to use. Preparations for oiling a street should be started several weeks before the actual oiling is to take place and preferably in the early spring. The street should be carefully shaped with an even slope of about one inch to the foot from crown to gutter. As the surface settles, the roadway should be dragged until it becomes hard, smooth, and free from depressions. The street is then ready for oiling. As the principal object of oiling is to prevent dust, there should be no dust on the roadway when it is oiled. If there is any dust it should be removed before oiling. This will involve some expense, but it will be found to be worth while. In case the decision to oil a street is not made until well along in the summer, when the surface has become dry and hard, the surface should be disturbed as little as possible, as it will be found difficult to get the newly-placed earth to pack properly. Oiling at this time of year should be avoided whenever possible as the results are sure to be inferior to those obtained when the road is oiled early in the summer.

The oil may be distributed with an ordinary street sprinkler, the adjustment of the spray to give the proper amount of oil being found by trial. Sidewalks and crossings should be kept clean and care taken to avoid forming pools at any point. The crossings may be covered with dust or sand before the oil is applied. After the street has been under traffic, the crossings may be cleaned.

After the oil has been spread, it should stand for a day without being covered, and then just enough sand should be spread upon it to keep the oil from being picked up by traffic. About two or three loads to the block will usually be needed. More sand may be applied after the street is opened to traffic, wherever there are spots that may seem to need it. Where a street is oiled for the first time, about one-half gallon to the square yard should be used. After the first application, if the street is oiled every year, one-third of a gallon to the square yard is all that is necessary. With oil costing $1.68 per barrel, the cost of oiling by the method described should be six or seven cents per square yard.

A permanent cement used for stopping leaks in steam pipes, where caulking or plugging is impossible, may be made by mixing black oxide of manganese and raw linseed oil, using enough oil with the manganese to bring it to a thick paste. Apply to the pipe or joint at the leak. It is best to remove pressure from the pipe, and keep it sufficiently warm to absorb the oil from the manganese. In twenty-four hours the cement will be as hard as the iron pipe.—*Mechanical World.*

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Single-Phase and Three-Phase Operation of Electric Furnaces*

By F. T. SNYDER†

While it somewhat understates the facts, it is convenient to remember that the electric furnaces in regular operation throughout the world use about one million horse-power. This power is used in the making of aluminum, calcium carbide and other carbides, the fixation of atmospheric nitrogen, the making of steel and a long series of metallic alloys, and to a considerable extent in the high temperature production of special chemical products.

The present electric steel-making capacity of the United States is less than 100,000 tons per year. The total production of steel from all kinds of fuel furnaces is some 30,000,000 tons. A number of years ago it became evident that steel, when required in small quantities, one or two tons a day, could be made at less cost in electric furnaces than in fuel furnaces. Three years ago, electric furnaces were put in operation that could make steel up to outputs of ten tons per day cheaper than was possible with fuel, under normal price conditions. During the last year electric steel furnaces have been operating which make it evident that steel in any quantity can be made at a lower cost than is practical in fuel furnaces. That is, it appears that in the near future, electric furnaces of certain types will make steel in large tonnages at a lower net cost than open-hearth and bessemer-converter equipment can do it. In other words, as rapidly as these facts become accepted and the plants can be financed, the steel-melting business of the United States will become largely electrical.

During the last year electric furnaces have been regularly operating in commercial service in which an open interior of considerable volume has been maintained at temperatures around 2500° Centigrade. This has made possible on an industrial scale, chemical operations of great importance that cannot be performed at lower temperatures. Coming at a time when chemical supplies from Germany are cut off by the War, this type of furnace meets a need and shows costs of production that indicate an extended use as rapidly as the plants can be prepared.

A great deal of thought and effort has been put into electric furnaces for melting copper alloys, and while furnaces have been built on a commercial scale, it has become evident that the power consumption in this direction will be of relative small importance. This is due to the commercial conditions of the copper-alloy business. Electric furnace costs, for construction and operation, increase relatively with decrease in size of furnace. Copper alloys are melted in a large number of small plants. Each plant makes small quantities of a number of different alloy mixtures and thus requires several small furnaces, each operating part-time. The small power-demand and low load-factor make the electric-power rate too high in these plants to enable the electric furnace to compete with fuel melting. There are a few plants melting a number of tons per day of the same copper alloy mixture and the high efficiency and low metal loss of well-designed electric furnaces make it certain that such service will become electric. The small number of such plants makes the total possible power load in this direction limited.

There is another class of alloys, containing one or more of the light metals, either combined with or free from iron, which may be expected to become of great commercial importance in electric-furnace work and in producing satisfactory loads for power producers. These alloys are largely used in steel production and are becoming of increased importance in the construction of air-craft equipment of various types. Owing to the relatively high value per pound of these alloys, their production will stand a relatively high power-rate.

In the aggregate a large amount of annealing and other heat-treatment work is being done in fuel-furnaces of low thermal efficiences, many of them down to 5%. This is a field for electric-furnace application that is being developed, and may be expected to extend to fairly large loads in metal manufacturing districts.

The generally low efficiency of night-work in many lines of manufacture makes it difficult in some cases to get electric furnaces into 24-hour operations. This usually means 12-hour operation, even where the men generally work ten or nine hours, as the furnace can take current for two or three extra hours in the morning during the heating-up period. Many electric furnaces are intermittent in the absorption of load. The material is treated in charges and the furnace has to be shut down while the product is being removed and a new charge introduced. In actual experience electric furnaces show an annual load-factor on 12-hour service of about 40%, and about 70% with 24-hour service.

Due to the intermittent character of the usual service, electric furnaces can generally be shut down during peak time without inconvenience. Practically all sorts of large electric furnaces can be shut down from two to four hours without serious loss of temperature. Under the generally existing schedules of power charges, it is well worth while for the user to operate electric furnaces on an off-peak basis. The most general and, at present, the most rapidly growing electric-furnace service is for melting steel in foundries. It has been found difficult to do satisfactory molding at night. The plan which has worked out well is to do all the molding on the day shift and at night melt and pour only. Under this plan the molders do not lose time

*Address delivered at the convention of the National Electric Light Association, San Francisco, June 1915.

†President, Snyder Electric Furnace Co., Chicago, Illinois.

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while the pouring is being done and the practical difficulties that were expected with this plan have been generally overcome. The result is an all-night load for the power producer.

Due to the size of the loads it usually happens that existing service lines are too small and special lines have to be installed. Even with the highest furnace voltages in practical use, the amount of copper involved generally makes low-tension service impracticable, even for furnaces near substations. Consequently, as the voltage has to be reduced at the furnace, the voltage of the primary service is unimportant from the point of view of furnace equipment. Any available voltage can be used. Furnaces are now taking power from the highest to the lowest transmission voltages. Substantially all industrial furnaces are at present operating on alternating current. Alternating current presents no disadvantages in furnace operation, while the convenience of change in potential, and the facility of measurement and regulation are of great advantage. There are several reasons why, in the future, furnaces may be expected to develop toward direct-current operation for higher efficiencies, but at present and for some time to come alternating current is the practicable form of electric-furnace power-supply. Up to about 1500 kilowatts, arc and resistance furnaces can be built for 60 cycles. Above that, the design for 60 cycles becomes difficult and the furnaces expensive. Furnaces at 25 cycles have been built up to 20,000 kilowatts each. Induction furnace design is more limited, and special low frequencies are required at 500 kilowatts and over. The large majority of industrial electric furnaces are operating from single-phase service. This is especially true in the larger resistance-furnaces making special chemical products, and of the carbide and alloy furnaces. A number of furnaces using three phases directly in the furnace are in use for melting steel. Two-phase furnaces have been built, but it is not probable that their use will extend materially, as they have the disadvantages of the three-phase types and are without the advantages of the single-phase forms.

Most of the energy losses in an electric furnace is connected with the means used for getting the power into the furnace. There obviously must be at least two electric connections, one to get the current in and the other to get it out. In industrial furnace design the furnace charge can in most cases be connected directly to one terminal. This reduces the number of movable electrodes to one, as the limiting case. From engineering considerations, a single-electrode furnace should be expected to have the highest efficiency and in practice this is found to be the case. A single-electrode furnace must necessarily be supplied with single-phase current. The practical question that ought to be clearly understood by power producers is that this higher efficiency will eventually force all electric furnaces to a single-phase basis.

It may be well in the beginning to appreciate the fact that this question of three electrodes or one electrode is not a matter of rival manufactures of the different types, each stoutly asserting the particular merits of his own device. The patent situation in this country is such that all manufacturers are quite free to build either single or three-electrode furnaces or both, as seems to them best for their customers. Actually each of the larger furnace-manufacturers has at one time or another built both single-phase and three-phase furnaces. Both single and three-phase furnaces are at present built by a number of competing makers.

Electricity can be generated and transmitted three-phase with a lower capital investment than can be done with single-phase equipment. The difference is about $2 per year per kv.a. of demand under the usual electric-furnace conditions. This has lead to the development of three-phase generating equipment and the adaptation of lighting and power loads to this service. With lighting, a number of small diversified customers and lamp outlets makes the proper distribution of the loads over the phases relatively easy. With power it was not nearly as easy. The old direct-current motor had proved both cheap and reliable, and satisfactory control-methods were in use, before three-phase distribution became general. Even today it is not at all easy for a power salesman to change a plant from direct-current to alternating-current motors.

Where the motor was doing work of an intermittent character, stopping and starting with variable speeds, it was and is now still more evident that the direct-current motor has characteristics that give it distinct advantages in this class of service. When in addition the motor had to be portable, and besides doing its work it had also to move itself about, the greater weight and lower efficiency of the alternating motor placed it at a distinct commercial disadvantage. These are the conditions of railway service and while the battle still goes on, the developments of the last few years make it quite evident that in railway service the facility and convenience of three-phase generation and transmission are not the only factors in deciding the adaptation of types of railway motor-equipment. In this, as in all lines of industry, the type of equipment that survives is the type that produces the largest net profit for the community, irrespective of how that profit is divided among the active participants.

In metal melting and the production of alloys a considerable majority of the operating furnaces are now single phase. For abrasives and heat treatment substantially all the regularly operating furnaces are single-phase. The proportion of single-phase furnaces is steadily growing in the face of almost universal three-phase power generation. As the electric-furnace types have developed under free competition, there obviously must be sound economic reasons for this situation. These can be found in the fact that single-phase current appears to be naturally better adapted for furnace work than three-phase current, just as direct current is better adapted to street-car work, and that the saving due to the use of single-phase current materially outweighs the apparent convenience of using three-phase directly in the furnace.

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It should be noted that many single-phase furnaces are running in groups in which the individual furnaces are distributed among the different phases of the generating-system. Also that standard three-phase equipment will deliver 75% of its three-phase capacity in the form of single-phase current.

Single-phase current in furnace-work has no direct benefit in itself except as it permits the use of a single electrode. The loss of power, the amounts of electrode and refractories used and the labor needed per ton of output are roughly proportional to the number of electrodes used. This makes the cost of operating a three-electrode furnace much higher than the cost with a one-electrode furnace. This is borne out by many records of practical operation extending over considerable periods of time. The reasons for this difference in cost are simple and when pointed out are readily understood. The commercial effect of this difference is of great importance both to the users of electric furnaces and to the sellers of electric power for this purpose.

The potential difference permissible in an electric furnace is limited, as in the case of electric motors, by considerations of safety for the operators of the equipment. This permits the voltage of the single-arc furnace to be about twice that of each of the arcs of a three-phase furnace with the same degree of safety. The greater heat losses of a three-electrode furnace make necessary the use of about 50% more power per ton of product, so that each electrode of a three-electrode furnace carries about the same amperage and is the same size, if made of the same material, as the single electrode of the single-phase furnace. Electrode consumption is largely a matter of surface-burning. The three-electrode furnace with the same electrode material, has three times the surface to burn and the electrode consumption would naturally be expected to be three times as high per ton of product.

In actual practice, it has not been found economical to use the same material for the electrodes of a three-electrode as for a one-electrode furnace. Electrode-cost is made up of two items, the purchase price of the electrode-material itself and the heat lost through the electrode during its life. The larger surface burning in the three-electrode furnace makes the cost of the electrode material of first importance. Graphite-electrodes cost three times as much per pound as do carbon-electrodes. Where so much is to be burned the use of the cheaper material is an enforced necessity. The relative conductivities of carbon and graphite are such that electrodes of somewhat more than double the diameter are required with carbon. In good engineering practice the three-electrode furnace has about 6½ times the electrode surface of a single-electrode furnace of the same daily output. Carbon burns more readily than graphite, so that the actual electrode consumption ratio in the best practice is about 9 times as many pounds of electrode per ton of output for the three-electrode as for the single-electrode furnace. The one graphite-electrode costs three times as much per pound as the three carbon-electrodes, so that the net result is that the electrode cost per ton of product for three-phase furnace is three times the cost for a single-phase furnace.

The principal unavoidable heat loss in an electric furnace is through the electrodes. Just as copper wire conducts electricity better than air, so a carbon electrode conducts heat much better than would the air in an empty electrode hole. With three electrodes of the same size as the single electrode, the heat loss would obviously be three times as great in the three-phase furnace as in the single-electrode furnace. Actually, the ratio is much higher, due to the economic necessity of using carbon electrodes in a three-electrode furnace. As used in the best actual practice the cross sectional area of the three carbon electrodes of a three-electrode furnace is about 15 times the cross section of the one graphite electrode of the single-phase furnace. Carbon has about half the heat conductivity of graphite, so that the heat lost through the three electrodes is about 7½ times the heat lost through the one electrode. However, with the single electrode furnace a contact is also required to connect the charge with the circuit. This contact loses some heat, hence the net result is that the heat loss due to the introduction of the current in a well designed three-phase furnace is about five times this heat loss in a one-electrode furnace.

Most of the refractory wear in an electric furnace is on the roof. The sides are banked up with relatively cheap material that keeps the walls from wearing. This roof-wear is largely around the electrodes and is partly due to the hot gases that escape between the electrode and the roof. With three electrodes this wear of the roof near the electrode would be expected to be three times as large with a three-electrode furnace as with a one-electrode furnace. In regular commercial operation the ratio of lining-wear is higher than three to one. This is in part due to the fact that three-phase current is used with three electrodes. This gives a difference of potential between electrodes 70% higher than the potential from each of the three electrodes to the bath. Firebrick at white heat is a relatively good conductor of electricity, having a resistance of about one ohm per cubic inch. Consequently, a considerable current flows between electrodes through the hot roof material. Futhermore this current-flow heats the roof just as the current heats the filament of an incandescent lamp, and heats it at just the places where the roof is already at the highest temperature. To reduce this leakage current between electrodes, the electrodes of a three-electrode furnace are movd as far apart as practicable. The farther they are moved apart the nearer the arcs come to the walls and the higher the cost of wall refractories per ton of product. With a one-electrode furnace the arc is in the centre at the maximum distance from the walls.

The electrode heat-loss is a considerable part of the total heat used in an electric furnace. The amount saved by using one electrode materially increases the number of heats put out per day. The fewer and smaller electrodes to be handled in actual practice, do

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away with one man from the furnace-crew. The smaller number of renewals of refractory material naturally results in a material saving of labor. The sum of these effects is such that for the same capacity of furnace in good practice, the cost of labor per ton of product is about one-third as much with the one-electrode furnace as is possible with the three-electrode furnace.

The variations in current in an electric furnace are due to changes in conditions in the furnace. In a melting-furnace the gases given off by the metal cause the slag to swell up in bubbles. In practice these slag bubbles rise up an inch or so. In the three-electrode furnace the arcs are about two inches long. The arc blows the slag away a half-inch so that the electrode is about 1½ in. from the slag. When a bubble swells up under the electrode the arc transfers itself to the bubble. With the top of the bubble only ½ in. from the electrode, the length of that arc momentarily drops to ½ in., which is one-fourth of its normal length.

In the three-electrode furnace each arc is in series with one of the other arcs. With one arc on the top of a bubble and the other series arc normal the joint resistance of the two arcs drops to ⅝ of the normal value. The current jumps to 8/5 or 160% of its normal value and as the bubble breaks the current goes back again to normal. With the one-electrode furnace the corresponding arc is eight inches long. When a bubble of slag swells up an inch the length of the arc is reduced to seven inches. The rise of current is ⅛ or 12½% of the normal value. The one-electrode furnace therefore never trips out the circuit-breakers protecting it.

With the 75-volt arcs used in the three-electrode furnaces the arcs break at a length of about three inches. With the 150-volt arcs used in the one-electrode furnace, the arc will pull out to 14 in. before breaking. When melting down scrap, the long arc transfers itself without breaking from piece to piece as the scrap melts, while the short arcs of the three-electrode furnaces go out when the scrap melts more than three inches away from them. The three arcs of a three-electrode furnace are mutually dependent, as each is the return circuit for the other two. When the one arc breaks, the current drops in the other two also. For these reasons the single-electrode furnace makes a much more uniform load on electric power service than does a three-electrode furnace. These changes of condition in the furnace are too rapid to be followed by a mechanical regulator moving the electrodes.

Geological Features of the Oklahoma Oilfields

By DORSEY HAGER*

The geologist coming to Oklahoma from California or Wyoming will be at sea for a short period. He must change his perspective entirely. In Oklahoma the folds are broad in comparison to the height. Fig. 1 shows a California fold. Fig. 2 shows an Oklahoma fold. In measuring the dip the clinometer must be dispensed with in most cases. Dips from 30 min. to 1° are general. With such low dips it is preferable to use an aneroid barometer, or a plane table and alidade for measuring dip. Such slight dips are, however, readily perceptible to the eye. The dip is usually to the west and varies from twenty to fifty feet per mile in the northeast portion of the State, and from fifty to one hundred and fifty feet per mile in the southern portion of the State.

Prospecting for oil in Northern and Central Oklahoma becomes primarily finding east or southeast dips, or else points where the prevailing westward dip is flattened. For an accumulation of oil it is necessary that the normal dip be checked or broken. An east or southeast dip will offset the normal dip. However, a flattening of the dip to form a terrace, as at *A* in Fig. 3 is sufficient to give commercial accumulations. The Glenn Pool, and several others are really terraces instead of well-defined anticlines.

There is little system to folding in Oklahoma. The folds are small non-continuous wrinkles. Fig. 4 illustrates such structures, which differ from the linear folds of the California anticlines, where several domes occur on one main fold. The Cushing field is exceptional, as there is a system of folding there. This is also true in the southeastern portion of the State. The general trend of the folds in the northern part of the State is northeast, but in Central-Eastern Oklahoma the strike is to the east. However, the anticlines seldom continue for more than a few miles.

In many places oil has accumulated, due to conditions that do not show on the surface, while the surface-evidence was unfavorable. Fig. 5 shows a normal dip to the west. Lensing or hardening of the sand up the dip has resulted in favorable conditions for accumulations. Normal faulting as in Fig. 6 causes many local accumulations. Reversed faulting, however, is rare. Faulting in Oklahoma is not severe, but is common enough to prove important in causing the accumulation of oil in paying quantities. Anything that breaks the normal dip is likely to give an accumulation.

The sediments of Oklahoma are older and more compact than those of California. Limestones and massive sandstones are far more common than in California. The oil horizons are Cretaceous, Pennsylvanian, and Mississippian. Oil may be developed in time from Ordovician, though this is doubtful. The Cretaceous

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is productive at Madill in the southern part of the State, but is not considered an important oil horizon. The Pennsylvanian is the principal producing formation, though some oil is also obtained from the Mississippian.

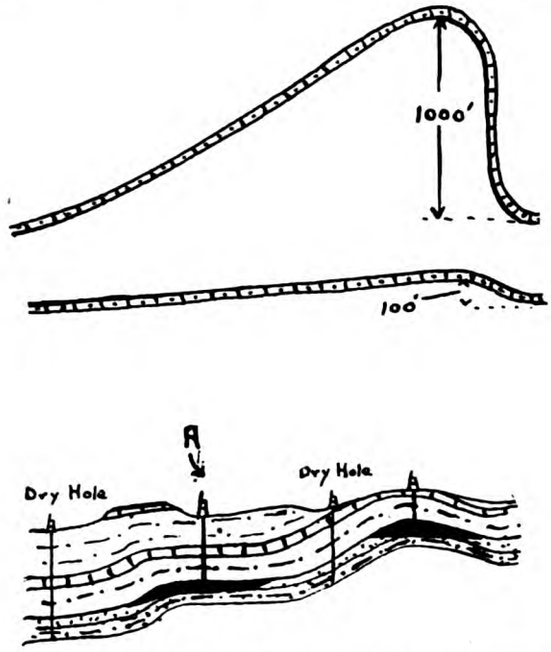

FIG. 1, 2, 3. EXAMPLES OF CALIFORNIA AND OKLAHOMA FOLDS AND OF FLATTENED DIP.

The probable producing area of Oklahoma is limited. The known producing sands are increasing in depth to the west, with the result that they will soon be too deep for economic development, even were folding found. It is difficult to find such folding, for the overlying Permian Red Beds make the work of the geologist

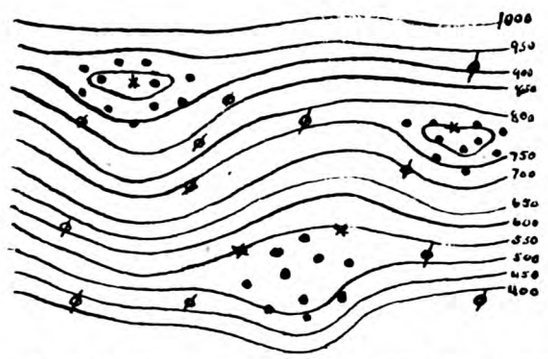

FIG. 4. EXAMPLE OF STRUCTURAL CONDITIONS IN OKLAHOMA.

difficult as they consist of soft shales and sandstones, which are hard to correlate and are so weathered that but few prominent scarps or dip-slopes are found as is the case with the Pennsylvanian and Mississippian sediments.

The topography in Oklahoma is of assistance in studying structure. The hills are capped by hard sandstones or limestones, which usually dip gently to the west and northwest. The east sides of these hills form steep escarpments, but the tops form long gentle slopes that are easily followed for long distances. The anticlines, or terraces, more often occur in the hills than in the valleys, many of the deep valleys being synclinal. It is puzzling at first to find that the oldest beds occur

FIG. 5. EXAMPLE OF WESTERN DIP.

quite often in the synclines, which have been eroded more deeply than the anticlinal axis. At first this worries one accustomed to conditions in California where the occurrence of older beds nearly always signifies a domed condition.

However the geologist in Oklahoma finds little difficulty in determining the geological structure of the country. Indeed, this may be done as easily as in California, once the elements of local geology are learned.

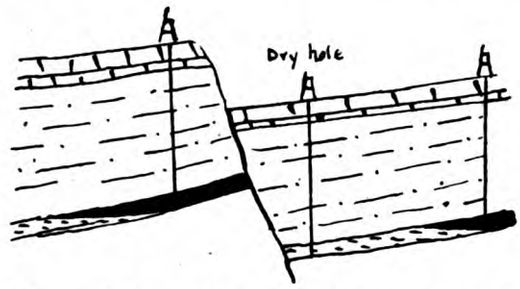

FIG. 6. NORMAL FAULTING CAUSING LOCAL ACCUMULATION.

Asphalt-paving on a plank-base is being used successfully in King county, Washington, particularly for increasing the service that may be expected from roadways supported on wooden trestles. An untreated planked-trestle in the vicinity of Seattle wears so rapidly that after about eighteen months of service it has become rough, and the automobile traffic, in particular, avoids it in favor of other routes, although the wear is not yet sufficient to warrant renewal. A 2-in. asphalt wearing-surface on a substantial 5-in. plank trestle-flooring has been in service for seven years on one of Seattle's main automobile suburban routes, and only moderate patching has been required. The longest service may be secured, it is said, by applying the asphalt when the plank is thoroughly dry, and if this is done the roadway should last, assuming good workmanship, until dry-rot destroys the plank.—*Engineering Record.*

The most northerly electric-lighting plant in Asia is at Yakutsk, Siberia, 2000 miles from a railroad. It remains completely shut down in summer, but during the winter the daily load-factor is extremely high.—*Mechanical World.*

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The Hydraulic Compression of Air

By A. E. CHODZKO*

It is interesting to the student of coördination of the development of industrial progress to note the features in its processes of evolution that are common to different lines, and in no division, perhaps, of that vast subject are they more conspicuous than in the generation and the utilization of motive power.

For instance, a jet of steam impinging upon vanes or buckets attached to the periphery of a wheel, or else issuing from a point of its rim was the first concrete form of a steam-motor; it now represents the most advanced type of that class of machinery, after an interval of many centuries, although the far more intricate reciprocating engine was gradually developed in the meantime. The direct use of air under pressure for raising water, which in the light of modern familiarity with their practical combination, offers an efficient method of pumping, was distinctly outlined in the well known 'Fountain of Heron.' Nevertheless, this early suggestion remained unheeded until many elaborate designs of pumping machinery had gradually been evolved and perfected. The same is true of the compression of air. The crude and classical 'Trompe Catalane,' used for forge-blast in the small charcoal-iron factories of southern France, had long been relegated to the position of a mechanical curiosity, and been superseded by motor-operated fans.

As higher air-pressures were demanded, the piston machine was developed to a remarkable degree of excellence. It was followed, in course of time, by the high-pressure centrifugal, better adapted to large capacities. Continued progress in that direction has brought back a process primarily based on the principle of the ancient 'Trompe,' namely, the hydraulic compressor.

Two main features seem to characterize this gradual progress of human ingenuity; the first, of a general, not to say universal nature, is the tendency of advancing knowledge toward a return from the complex to the simple. In almost every industrial effort, the desired object is first attained by some intricate and cumbersome process or device. This is followed by a gradual blending of its useful elements into a smaller number. Later comes the weeding out of unnecessary intermediates between power and resistance. The second tendency, less general perhaps, than the former, because it admits of of some exceptions, is the discarding of intermittent in favor of continuous motion. These exceptions are found in cases where great variation of speed, or frequent reversals in the direction of motion are a necessity; they do not detract however, from the logical and general character of that tendency.

The hydraulic compression of air is the subject of the present paper. This can hardly be termed a novel process, since, aside from the remote origin already indicated, the first patent covering its application on a large scale was taken out by Joseph P. Frizell in 1878. The following quotation from his treatise on 'Water Power' gives a comprehensive presentation of the principal features of that process.

"It is founded upon the familiar observation that water thrown into commotion breaks into foam, and becomes impregnated with minute air-bubbles, and upon the further fact that these bubbles rise through water with a very moderate velocity, and in a descending current, are carried downward and subjected to a pressure conformable to the depth. Fig. 1 shows the arrangement for applying these principles on a practical scale. It assumes a fall created by a dam on a running stream. It

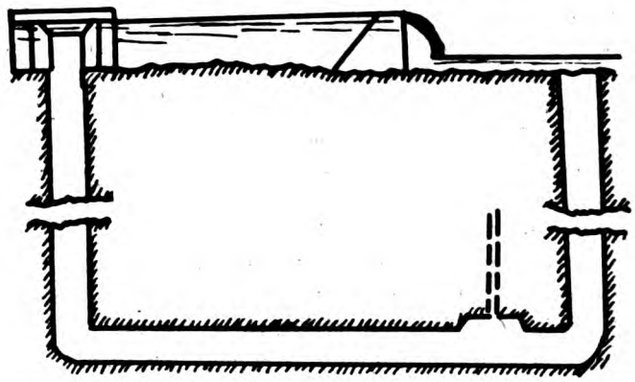

FIG. 1. SKETCH OF FRIZELL COMPRESSOR.

also assumes, what is generally the fact at a fall or rapid, a rock formation at no great depth. On the upstream side of the dam, a vertical shaft descends into the ground to a depth corresponding to the required pressure. At that depth, its direction changes to horizontal, and it pursues this course to a point below the dam, where it joins a second vertical shaft opening into the river. Around the entrance to the shaft, a masonry structure rises to the elevation of the dam or something more, and is provided with means for controlling the influx. Over the horizontal passage, a capacious chamber is formed, provided with an impervious lining. The air transmission-pipe leads from this chamber. Water entering the descending shaft from different directions, meets with a high relative-velocity, and is thrown into violent commotion which impregnates it with air-bubbles of a minute and very uniform size; such bubbles tend to rise with a velocity of no more than one foot per second, and the descending current being four feet or more, they are carried downward. In the horizontal part of the passage, the air is free to rise and accordingly enters the air-chamber, and there accumulates under a pressure corresponding to the depth of the surface of water in the chamber below the surface of the stream. The water divested of its burden of air pursues its course, and rising through the ascending shaft, joins the river.

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"The compression in this method takes place isothermally, and avoids one of the principal sources of loss in machine-compressors. The losses inherent in the method are:

1. The head expended in impregnating the water with air, which includes the head due to the initial velocity, a fall of one foot in entering the shaft brings in the water from both sides with a velocity of eight feet per second, and these two currents meet with a relative velocity of sixteen feet per second, which creates a sufficient commotion.

2. A loss which may be called the 'slip' due to the velocity with which the bubbles tend to rise. It is obvious that the rise of the bubbles during the descent of the water is a lost motion, to be deducted from the efficiency of the system.

3. The head consumed by the friction in the channels.

"A committee of the Franklin Institute gave its attention to this method, and in a formal report, pronounced it identical with the ancient *trompe*. This statement is entirely incorrect, and reflects little credit upon that time honored institution. The conclusive and indisputable criterion between the two methods is this: The *trompe* cannot produce a pressure equal to the working head, or closely approaching the same. The device under consideration can produce a pressure many times the working head."

Considering the device on its general lines, a certain volume of water in the intake is allowed to fall into a vertical shaft, entraining by suction and by adhesion some atmospheric air, and gradually compressing it. The falling water is then deflected through a horizontal passage, where it meets a collecting-chamber. At this point the air, through its buoyancy, separates from the water and is led by a pipe to any place where it is intended to use it. The water from which the air has been separated is again deflected up another vertical shaft leading to the tail-race.

In the complete device there is but one piece of machinery, namely, the controlling-device for the admission of air and water. This device is practically stationary. No attendance is necessary, and if the shafts and passages have been carefully built and secured against leakage or caving by erosion, there is no apparent reason for considering it other than a permanent structure unless, perhaps, in the case of unusually gritty water.

It may be noted that aside from the small amount of air that might remain in suspension in the escaping water, the latter reaches the tail-race in the same condition as to pressure as when it left the intake. The work performed is therefore due to the fall of a certain volume of water from a height equal to the difference in elevation between them. This quantity may be computed exactly.

Whatever intermediate process may take place in transit between these two terminals, the result is the production of a certain volume of compressed air, capable of yielding an amount of useful work that can likewise be correctly determined. The practical efficiency of the system is the ratio of these two quantities of work. In practice efficiencies have been obtained comparing favorably with the most elaborate air-compressing plants.

It will be seen that the air pressure depends solely upon the depth of the return-shaft leading to the tail-race, and is therefore apparently independent of the head. This, however, is not strictly true. A higher working head is necessary for an increased air pressure.

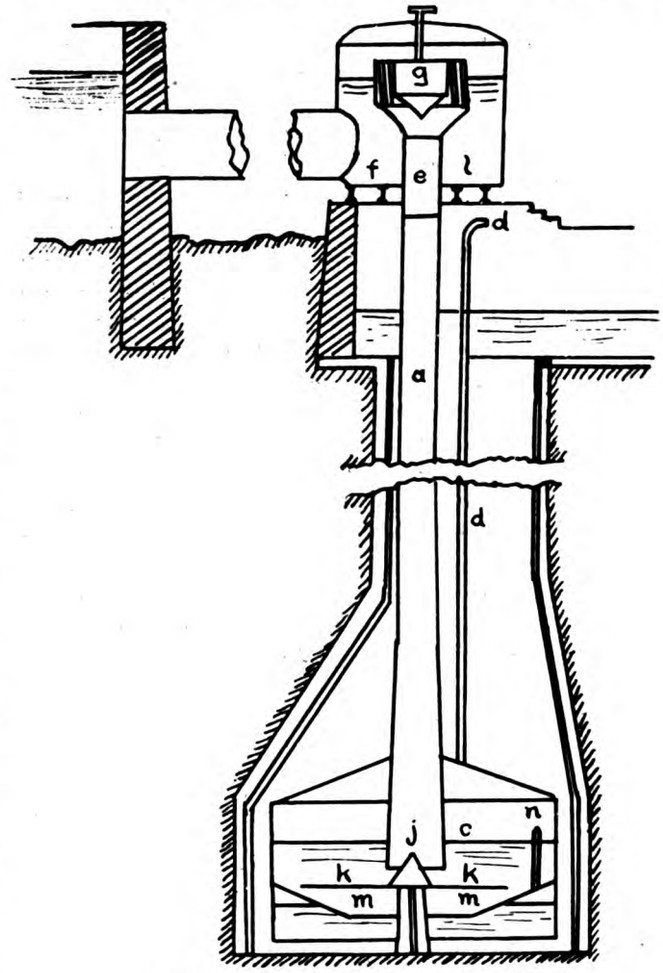

FIG. 2. SKETCH OF TAYLOR COMPRESSOR.

The experimental results realized with the Frizell hydraulic compressor led Chas. H. Taylor of Montreal, Canada, to propose a modified form of that machine. A machine of this type was erected in 1896 at the Dominion Cotton Mills, Magog, Quebec.

Fig. 2 is a sketch of the compressor used in that instance, taken, together with the following abridged description, from 'Compressed Air Plant,' by Robert Peele. "For the Magog Mills, a 128-ft. shaft was sunk to give the desired head and pressure; in it was erected a large vertical compressing-pipe *a*, 3 ft. 8½ in. in diameter, the lower part gradually increasing to 4 ft. 8 in. and made of $\frac{5}{16}$ in. steel plate. This pipe passes through the bottom of a cylindrical intake *b*, 12 feet in diameter by 12 ft. high, connected to the supply flume. The pipe extends to a point a few feet above the bottom of the shaft, passing through the top of a cylindrical bell *c*, 17 feet in diameter and 12 feet high. This bell, entirely similar to those used for the storage of illuminating gas,

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is open at its lower end, and supported about 18 inches above the bottom of the shaft, the top of which opens into the tail-race. The bell is entirely immersed in the return water. Immediately under the open lower end of the pipe, *a*, a deflecting cone *j*, attached to a horizontal circular baffle-plate *k*, about 14 ft. in diameter, is secured at the centre of bell *c*. A pipe *d*, attached to the top of that bell, leads the compressed air to any place intended for its use. Returning to the top of the pipe, *a* in the intake, one finds a telescopic section *e*, riveted to a bell-mouth *f*. Immediately above this is a cylindrical head-piece *g*, open at its top and terminating below in an inverted conoid that penetrates the bell-mouth *f*. The headpiece is suspended to a central screw, by means of which it may be raised or lowered at will. This regulates the size of the circular inlet of water into the pipe *a*. The headpiece carries on its periphery thirty 2-in. iron pipes 4 ft. long, open at the top, which projects above the water level in the intake. Into each of these, and close to its lower end, are screwed thirty-two short horizontal ⅜ in. pipes directed into the annular inlet-opening.

As the inrushing water passes among the small pipes, it tends to create a vacuum. Atmospheric pressure drives the air through the pipes in the form of small bubbles entrained by the water. With the water, they are carried down pipe *a*, their pressure increasing with the depth below the surface. As this emulsion of air and water issues from the pipe, it impinges against the baffle-shield *jk*. Its flow is abruptly swerved radially and at right angles, while the area of the stream is considerably increased. Its velocity decreases accordingly, and the bubbles, rising to the surface, are collected into the receiver formed by the upper portion of the bell *c*. The water, having lost most of the entrained air, is deflected by an apron *m*, toward the centre of the bell, and continues on its way to the tail-race. In so doing it follows the slanting outer face of the apron *m*. The remaining air collects at its connection with the plate *k*, and is led by the pipe *n*, to the receiver, and thence, through the pipe *d*, to the place of use.

The minute subdivision of the air increases its surface of contact with the cooling water to a great extent. The compression has been found to be actually isothermal. In a series of tests made by C. H. McLeod of McGill University in August 1896, the best efficiency in the Magog plant was found to be 62.4% with an effective air pressure of 52 lb. gauge. This was realized with a delivery of 4005 cu. ft. of water, entraining 1095 cu. ft. of free air, per minute, the available head being 22.3 feet. Subsequent experience with this system has shown that the parts were not correctly proportioned in that first installation, and greater efficiencies have been realized in more recent application."

The same source of information mentions a plant built for the Kootenay Air Supply Co. at Ainsworth, British Columbia. The first portion of the induction pipe *a*, Fig. 2, which is 33 in. in diameter, is carried on a wooden tower 110 ft. high, whose base is at the level of the tail-race, and continued by a vertical shaft 105 ft. deep, the effective compressing-head being 107 ft. The main pipe-line 9 in. in diameter, is two miles long. It discharges from 4200 to 4600 cu. ft. of free air per minute, producing 600 hp. after compression. The volume of water and the efficiency are not mentioned. Owing to improved constructive features, the latter must have reached, if not exceeded 70%.

Another large plant was built in 1906 at the Victoria Copper Mine, Ontonagon Co., Michigan, containing three units in all. In one of them, with a working head of 70 ft., 14,820 cu. ft. of water was used to deliver 11,930 cu. ft. per minute at 114 lb. gauge-pressure, corresponding to 1623 hp. and an efficiency of 82.27%. It is expected that the three units will deliver 4000 hp. in all. The single unit at present in use operates, among other machines, a 500 hp. hoist designed for 4000 ft. beside seven pumps. The cost per horse-power per year is $2.25, including all operating expenses.

Other recent installations are, two in Germany and one on the Shetucket river, near Norwich, Connecticut. The latter plant was described in 'Compressed Air,' in April 1906. An underground plant developing about 60 hp. has been constructed in the silver mines of Clausthal, Bohemia.

The most important point of difference between the Taylor and the Frizell designs lies in the process adopted to induce the entrainment of air at the intake. The former uses a large number of small inlet pipes, 1800 being used at the Victoria Mine. That is, it carries the preliminary subdivision of the air intended for compression as far as possible, apparently with the idea of increasing the cooling surface. In the Frizell compressor, the headpiece consists of a funnel, in the shape of a square truncated pyramid, with its apex downward, attached to a telescopic piece of pipe. The following excerpt is from Frizell's 'Water Power.'

"Fig. 1 shows a telescopic pipe entering the descending shaft, carrying a hopper-shaped mouthpiece, which we will call the 'hopper,' and adjustable vertically by mechanism not shown. The hopper is guided in its vertical movement by four piers or guides. These form four channels of approach, through which four currents of water enter the hopper, and in meeting cause the necessary commotion. It was clearly shown by the writer's experiments at Minneapolis, in 1880, that throwing the water in commotion is an effective mode of impregnating it with air.

"Any arrangement of pipes for this purpose appears to the writer entirely superfluous as well as objectionable. The pipes could not fail at times to become clogged with floating debris to the extent of wholly arresting the flow of air. In the arrangement of Fig. 1, trash of every kind, blocks of ice, and even logs could go through the system without embarrassment or interruption, not even a rack being required. In this disposition, the position of the hopper determines the quantity of water drawn. The quantity of air regulates itself, and is neither more nor less than the given quantity of water can carry. If the descending column is so loaded with air that it does not preponderate sufficiently against the ascending column,

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the water in the former will rise, the commotion will diminish, and less air will enter. In the contrary case, the water falls, commotion increases, and more air is taken in."

In the presence of two different designs, both evolved by persons of evident technical qualifications, and both founded on actual experience, a third party not possessing the latter advantage, can offer no comment other than remarks suggested by the records.

As the tops of the air-inducing pipes in the Taylor compressor stand above the water level in the intake, their obstruction by floating debris seems probable. At the same time, an examination of the Frizell design suggests the possibility at least of blocks of ice or floating logs lodging in the air chamber, whence their removal would be impossible without shutting off the water, and pumping out the underground portions of the plant.

Leaving aside the obvious superior simplicity of the hopper, and considering only the relative effectiveness of the two designs, the following foot-note from 'Compressed Air Plant' by R. Peele deserves insertion.

"Since the Victoria plant was put in operation, trouble has been experienced by the freezing up of the small pipes of the intake-heads, due to the severe winter climate of the region. This has led to the removal of the heads, as originally designed, the water being allowed simply to flow into the top of the compressing pipes. I am informed that the capacity of the plant in cubic feet of free air compressed per minute, is practically the same as when the intake heads were in use."

This seems to show that the particular arrangement of the air intake has no controlling influence on the practical efficiency of the plant. But the statement emphasizes, in a still more decisive manner, the simplicity of that system of air compression. It may certainly be contended that in mountainous regions, compressed air may often be produced at a moderate cost of first installation and that the operating expenses would be, in not a few cases, practically negligible.

A self-suggested objection lies in the cost of sinking a shaft of sufficient depth to secure a convenient air-pressure, as such a shaft must be of substantial construction to insure permanency. This objection would doubtless be well founded in some instances; yet it might frequently be overcome by having all the parts of the plant laid upon or built at the surface.

Fig. 3 illustrates the case of a ditch or flume running along the slope of a mountain. This is dammed at A and the water is led by the pipe AB to the air receiver B. This might be built above ground of reinforced concrete, or else, be excavated, lagged and cemented to make it air tight. The use of pressure tunnels in hydro-electric plants shows that such construction may be both inexpensive and substantial. The water returns through another pipe BE to a point E located at the proper vertical distance below A to secure the desired power. The same water is then returned to the ditch at F, the section of the tail race EF being, of course, larger than of AF. All of the water is available for other uses below the position of the compressor. The portion AF might be omitted altogether and replaced by a short diversion canal AE, to be used if it is desired to dispense with the compressor.

Similar plants could be established along a stream, either for operating machine-drills in a mine or tunnel, for pumping water to a point above the level of the ditch, or for still other purposes. Their design would obviously be governed by local conditions. For instance, the topography might not permit the extension of the pressure pipes far enough downward for raising the air to a sufficient working pressure. In such a case, the air might be delivered at a lower pressure, and conveyed to a piston-compressor, the hydraulic portion of the plant acting as the first stage in compound work, and permitting the use of a smaller machine to complete the compression.

In the case of a certain California mine, the total available head was such that the water wheels operating the

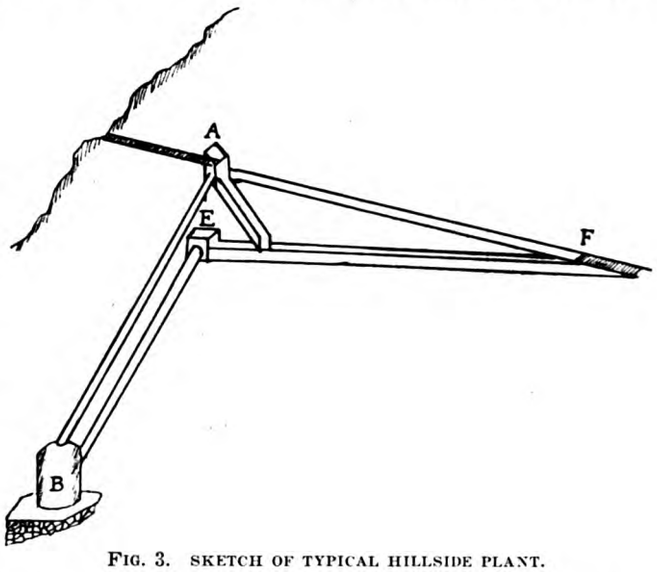

FIG. 3. SKETCH OF TYPICAL HILLSIDE PLANT.

hoist and the air-compressors are about 130 ft. above the river. Under these conditions, the tail water of the wheels, which was going to waste, at a moderate cost could have been utilized to develop a considerable amount of compressed air. This air could have been used either to dispense with one half of the duplex machine in use at the shaft, or to operate an air-lift pump. As it was the pump frequently required so much air as to reduce materially the amount available for the machine drills.

Like other processes apparently simple in principle, the hydraulic-compressor requires careful study in its practical design, in order to attain efficiency in the coördination of the various parts. The detailed treatment of a concrete case would, perhaps, prove a rather arid peroration to this paper, but its general lines may briefly be presented. The action of this machine is based upon the downward motion of a column formed of a mixture of air and water, against the back pressure of an ascending column of water alone. It may, therefore, be considered as the counterpart of an air-lift, inasmuch as the excess in weight of the descending column over the back pressure must be sufficient to cause the entrainment of

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the proper amount of air, and to overcome the other elements of resistance.

The analytic theory of the motion of air in contact with flowing water is far from simple, it involves among other factors, the shape of the air and water ajutages. The degree of certainty of its conclusions would not, in the present case, compensate for its abstruseness. The adjustment of the water and air supplies must remain facultative, whether or not, as contended by Mr. Frizell, that adjustment is invariably automatic.

Starting from the conclusion of his experiments, that fine air bubbles rise in the water at an approximate velocity of nine inches per second, the velocity varying as the square of their diameter, it is evident that water must enter the induction pipe at a speed materially greater than that figure, the more so, as all available records of tests on entrainment devices point to a low efficiency. Furthermore, the necessary velocity, and consequent loss of head, will be reduced by subdividing the entering air into minute bubbles, as done in the Taylor compressor.

Experience has set some practical values of the proper velocity, which is said to be from 12 to 16 ft. per second.*

The first step, in designing such a machine, is to assume a definite value for that velocity, for instance, 14 ft. The weight of the column of water to produce that velocity is 190 lb. per sq. ft., but it may be taken as 250 lb. to cover frictional and other losses.

If R is the volumetric ratio of free air to water at the head of the induction pipe, d the weight of one cubic foot of free air, P_0 the atmospheric pressure, and P_1 the absolute receiver pressure desired, both in pounds per square foot, the weight of one cubic foot of mixed air and water is:

At the top of the induction pipe: $\frac{62.4 + dR}{1 + R}$

At the bottom of the induction pipe:

$$\frac{62.4 + dR}{1 + R\,\frac{(P_0)}{(P_1)}}$$

Giving an average value:

$$\frac{62.4 + dR}{2}\left[\frac{1}{1 + R} + \frac{1}{1 + R\,\frac{(P_0)}{(P_1)}}\right] = m$$

If we assume H to be the height of the induction pipe and h that of the pressure pipe; we may write, as a first conditional equation:

$$mH = 62.4\ h + 250 \quad (1)$$

E being the efficiency of the process, and the compression being isothermal, another relation, when c = cubic feet of water and v_0 cubic feet of free air per minute is:

$$62.4\ cE\ (H-h) = P_0\ V_0\ \mathrm{Log_e}\ \frac{(P_1)}{(P_0)} = P_0\ R_c\ \mathrm{Log_e}\ \frac{(P_1)}{(P_0)} \quad (2)$$

But

$$P_1 - P_0 = 62.4h$$

so that at sea-level, for instance, equation (2) becomes:

$$0.0295\ E\ (H - h) = R\ \mathrm{Log_e}\ (1 + 0.0295\ h) \quad (3)$$

*Gibson's 'Hydraulics and Its Application.'

The air pressure is a known quantity, and so is the working head $(H\text{-}h)$ so that E and R may be determined from equations (1) and (3).

This will give a first idea of the combination of the assumed numerical values, but a more accurate estimate of the detailed elements is, of course, necessary for different velocities in the induction pipe; the separation of air from water is the most important contributory factor of the efficiency, as the proportion of air passing to the tail-race either in suspension or in solution, affects the back pressure. It hardly need be said that aside from the computable data, the practical results of existing installations have to be taken into careful consideration.

The dominant feature of the hydraulic process is a considerable reduction in operating and maintenance expenses as compared with mechanical installations. For great capacities and high air-pressures, the first cost might reach large figures yet would compare favorably with that of a regular power-plant of the usual types, while the obtainable efficiency is decidedly higher. For small mines or tunnels, remote from manufacturing centres and difficult of access, the system should prove valuable in many cases.

Brass or bronze is a poor material for springs as compared with steel. Occasionally, conditions arise where a non-ferrous metal has to be used. Brass possesses greater resilience than phosphor-bronze, but is liable to crystallization, although alloys containing iron are said to be less affected this way. The following brass and bronze mixtures suitable for the purpose are given in a recent issue of *The Foundry*. Brass-spring mixture: Copper, 70 lb., which is melted under a cover of charcoal and then thrown lightly on top of the molten metal; 1 lb. of yellow prussiate of potash wrapped in paper; close the furnace for five minutes and then observe whether the water of crystallization has been driven off from the potash. If so, stir the potash into the copper, exercising care in performing this operation, and add 2 oz. of manganese-copper. After again stirring the metal, add 29 lb. 10 oz. of zinc, and lastly, 6 oz. of tin. Phosphor-bronze mixture: Copper 94¾ lb., tin 5 lb., and 15% phosphor-bronze ¼ pound.

When boring holes in which the depth is great and the diameter small in comparison with the size of the boring-tool, chips are apt to collect in the bottom of the hole and raise the tool so as to make it cut larger than it should. If a small hole is drilled in the boring-bar close to the cutter and a piece of soft iron wire is driven in the hole and wound round the bar spirally—right hand if the bar is cutting right hand and left if cutting left—and the end finished off, the spiral will keep the hole clear of chips.—*Mechanical World.*

Removal of rust from iron products is frequently necessary. Experiments in England prove that all chemicals tried for this purpose failed, as none would remove the rust without also dissolving some of the iron.

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Practice in High-Head Hydraulic Plants*

By J. P. JOLLYMAN†

It is the purpose of this paper to consider high-head practice chiefly as exemplified by Pacific Coast plants.

Pipe-lines.—By reason of the high pressures carried and their length, pipe-lines for high-head plants, and particularly for plants having 1000-ft. head or over, are a problem of importance. Cast-iron pipe with bell and spigot joints has been used in a few installations in the past on heads as high as 700 ft. Pipe-lines of this kind are not very satisfactory since the cast iron is not well adapted to withstand shock from a sudden change in water pressure nor the stresses set up by changes in temperature. The joints cannot of themselves withstand the tendency to pull apart hence the pipe must be held in alignment by being covered with earth or be supported on a continuous line of concrete piers. While it may be the best material for high-pressure fire-systems the conditions on a steep hillside are so different from those in a city street that cast iron is no longer considered a suitable material for high-head pipe-lines, and it has been abandoned in favor of other materials.

Present practice favors the use of steel with either riveted or welded joints. The use of riveted pipe in California is, in a way, a development of the practice which was followed by the hydraulic miners. One of the most noteworthy examples of early practice in the use of riveted pipe is the syphon crossing the west branch of the Feather river near Cherokee, which has a maximum head of 887 ft. and a diameter of 30 in. This pipe was installed in 1870 and is still in fair condition. Riveted pipe is reliable since hidden flaws in the plates are rare and the strength of the joints can be determined with accuracy. It is so flexible that bends up to about 9° can be made at any round-about joint and small changes or corrections made at every field joint. Pipe of this type has been cold-rolled and cold-punched up to 1¼ in. thickness and down to 52 in. diameter. Thicker riveted pipe has been made but the holes in this have been drilled and the process of manufacture is more like that of boilers than of typical riveted pipe.

The disadvantages of riveted pipe are the excess weight in the cross-section due to the efficiency of the riveted joints being 87% or less, and the higher coefficient of friction due largely to the protruding rivet heads. Pipe with welded longitudinal seams and with either riveted or flanged round-about joints has the advantages of minimum weight and low friction losses and is being used for high-head work. In general welded pipe has not proved quite as reliable as riveted pipe but the process of welding has been rapidly improved and the new welded lines are satisfactory.

It will generally be found that a material saving in weight can be made by tapering the diameter of a high-head pipe-line in such a way that the total head lost in friction will be the amount considered permissible, rather than by selecting a uniform diameter which will give the same total friction-head. This is particularly true where the profile is such that the slope increases as the head increases. In a recent riveted line whose profile had this characteristic, the diameter was tapered from 72 in. at the upper end to 52 in. at the lower end where the head was 1375 ft. One of the latest welded lines has been tapered from 42-in. diameter to 36.8-in. equivalent diameter, the 42-in. pipe being divided into two 26-in. pipes.

The problem of anchoring a pipe on steep slopes is important. The weight of the pipe and the stresses set up by changes in temperature have to be considered. The lines must be rigidly anchored at the power-house and should be anchored to concrete piers at sharp bends. Expansion stresses in a straight line held rigidly at each end are about 195 lb. per sq. in. for each degree Fahrenheit change in temperature. Experience indicates that horizontal and vertical bends in a long pipe are of great advantage in absorbing the changes in length due to these stresses. Slip-joints have been used at various points along the pipes, but they are a cause of serious trouble in that the pipe tends to blow apart at the joint. The present tendency is to avoid long runs of straight pipe and to use slip-joints only at points near the upper end of the pipe.

Gate-Valves.—Special fittings such as Y-pieces or gate-valves are generally required at the power-house on nearly all high-head lines. The practice of connecting all pipe-lines to a common header-pipe and taking all the connections from the header to the water-wheels has been abandoned for the simpler plan of feeding a certain number of wheels from one pipe and reaching these wheels through Y-pieces. These Y-pieces are usually of cast steel heavily ribbed to strengthen the sections that are not circular.

Gate-valves are an item of great importance. The disc of a 36-in. valve under 1000-ft. head must withstand a pressure of 440,000 lb. when closed. Present practice favors a gate with a single disc and with an operating-gear of sufficient power to move the disc under full-head. With so powerful an operating-mechanism any form of wedge-disc is objectionable, since the stresses in the body of the gate may be greatly increased by the wedging of the disc; besides, the great pressures against the disc due to the water alone will be sufficient to prevent leakage.

The Johnson or needle-valve form of gate seems to be

*Read before the convention of the National Electric Light Association, San Francisco, June 1915.

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well adapted to high-head requirements particularly where closure under normal or abnormal velocity may be required. This valve is a recent development and has not yet come into general use.

In assembling the special fittings which connect the pipe-line with the wheels it is usually necessary to connect between two parts whose positions are fixed. In doing this it is of great importance that it shall be so done that no stresses will be thrown on the fittings by attempting to bring together surfaces which do not fit exactly. A much better way is to provide one piece in every assembly which can be fitted into place in the field.

Water-Wheels.—The water having been delivered to the power-house under a head ranging from 250 to 2000 ft., the next problem is to secure a water-wheel which will efficiently utilize the available energy. Two types of water-wheels are used: the Francis turbine for heads up to 700 ft., and the impulse water-wheel for any head up to 5000 ft., a plant in Switzerland having a head of 5412 ft. The suitability of either type for any given conditions of head, speed, and the horse-power depends upon the relation of certain functions of their physical proportions which are conveniently expressed as the 'specific speed' of the wheel. This term is defined as the speed of a wheel, whose ratio of jet diameter to impulse-circle diameter, in the case of the impulse wheel, or whose ratio of runner opening to runner diameter, in the case of the Francis turbine, is the same as the wheel under consideration, but whose dimensions are such that it would develop 1 hp. at 1-ft. head.

The formula for the speed of this assumed wheel is

$$Ns = \frac{Rpm \times Hp}{H^{5/4}}$$

where Ns = specific speed
Rpm = revolutions per minute
Hp = horse-power delivered
H = head in feet

Present practice indicates that the Francis turbines are suitable for heads as high as 700 ft. and specific speeds as low as 12 and that impulse-wheels may be operated on any head up to 3000 ft. or over with specific speeds as high as 4 for heads up to 2000 ft. There are so few plants employing heads above 2000 ft. that practice has not shown just what specific speeds can be reached with impulse-wheels under these higher heads. Fig. 1 shows a graphical solution of the equation for specific speed for heads from 100 to 2500 ft., speeds from 200 to 720 r.p.m., and from 1000 to 25,000 hp. An inspection of this diagram shows that there are many combinations of head, speed, and output which give specific speeds between 4 and 12 and which therefore cannot be met by either a Francis turbine or by a single-jet impulse-wheel. To secure a proper solution it becomes necessary to change the speed, or the output required from a single jet wheel. In general it may be said that the most desirable speeds for water-wheel generators from 3000 to 15,000 kw. are in the neighborhood of 400 r.p.m., and that these speeds tend to call for impulse-wheels having high specific speeds and Francis turbines having low specific speeds.

From the standpoint of efficiency the water-wheel is by far the most important part of the plant since under favorable conditions a greater gain can be had in the efficiency of the wheel than in any other part. It is therefore essential that the speed and output of the units be selected with reference to securing the best possible conditions for the water-wheels. Minimizing leakage and taking care of end-thrust are problems of

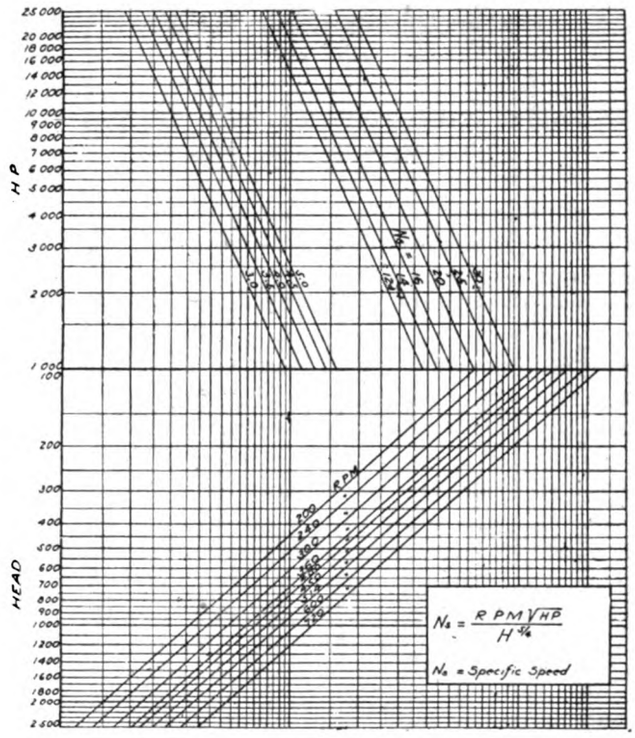

FIG. 1. CHART FOR COMPUTING SPECIFIC SPEED.

great importance in the design of Francis turbines. Present practice gives a satisfactory solution for both these problems. Balancing is accomplished automatically by the proper arrangement of the leakage ports.

The attachment of the bucket to the wheel-centre and the shaping of the bucket so as to avoid interference with the jet are most important in impulse-wheel design. At 1000-ft. head the impact of the jet on the bucket is 21,650 lb. for 10,000-hp. output. The stresses on the bolts holding the bucket to the wheel are therefore high and change very rapidly as the bucket passes under the action of the jet. The best forms of attachment thus far developed are (1) 'chain bolting' using a double wheel-centre and a bolt which passes through the lugs of two adjacent buckets, or (2) the 'two bolt' or 'three bolt' arrangement which employs a single disc with buckets having two lugs straddling the disc and extending for some distance toward the wheel centre. Two or three bolts, preferably tapered, are passed through the lugs and the wheel-centre.

Control.—The only method of governing the Francis turbine consists in varying the positions of the wicket-gates which changes the amount of water supplied.

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DATA ON HIGH HEAD HYDROELECTRIC PLANTS

	Plant	Company	Head S=Static E=Effective	No.	Length	Pipe Lines Size	Material	No.	GENERATORS Kw	Volts	No. each Generator	WHEELS Type	HP Each Wheel	RPM	Specific Speed	Arrangement of Unit	Method of Governing	
1	Big Creek No. 1	Pac Lt & Pr Co	2 150 ft S	1	8 422 ft	84 in 4 ½ by 42 in 8 by 36 in	Riveted Welded Welded	2	17 500	6 600	2	Impulse	10 000	375	2 5	2 Bearing horizontal	Needle nozzle and relief valve	1
2	Big Creek No. 2	Pac Lt & Pr Co	1 870 ft S	2	about 2 700 ft	42 in	Welded	2	17 500	6 600	2	Impulse	10 000	375	3 0	2 " "	Needle nozzle and relief valve	2
3	De Sabla	Pac Gas & El Co	1 531 ft S	2	6 080 ft	90 in	Riveted & welded	2 2	2 000 5 000	2 400	1	Impulse	3 000 7 500	240 400	1 4 3 5	2 " "	Deflecting needle nozzle	3
4	Stanislaus	Sierra & S F Pr	1 495 ft S	2	4 200 ft	66 in 48 in to 38 in	Wood stave Riveted	4	8 500	4 000	2	Impulse	7 000	400	3 5	2 " "	Deflecting needle nozzle	4
5	San Joaquin No. 1	San Joaq Lt & Pr Co	1 420 ft S	2	4 100 ft	44 in 38 in	Riveted Welded	4	4 000	2 300	1	Impulse	6 100	400	3 5	2 " "	Needle nozzle and needle relief valve	5
6	Drum	Pac Gas & El Co	1 375 ft S	1	6 214 ft	72 in to 52 in	Riveted	2	12 500	6 600	2	Impulse	10 000	360	4 2	2 " "	Deflecting needle nozzle	6
7	Norrega	Michoacan Pr Co	650 ft E	1	5 600 ft			2	3 500		1	Francis Single discharge	6 000	514	15 0	4 " "	Wicket gate with relief valves	7
8	Centerville	Pac Gas & El Co	527 ft S	2 1	2 565 ft 2 565 ft	24 in 42 in to 36 in	Riveted	1	5 500	2 300	1	Francis Single discharge	9 500	400	14 0	4 " "	" " " "	8
9	Power House No. 5	Pac Gas & El Co	530 ft S	1	8 552 ft	96 in 84 in to 66 in	Wood stave Riveted	1	12 500	6 600	1	Francis Single discharge	20 000	360	20 0	2 " "	" " " "	9
10	Coleman	N Cal Pr Co	487 ft S	2	3 600 ft	72 in to 60 in	Riveted	3	4 000	6 600	1	Francis Single discharge	7 000	450	20 0	2 " "	" " " "	10
11	Big Bend	G W Pr Co	453 ft S	4*	575 ft	60 in	Welded	4	10 000	11 000	1	Francis Single discharge	15 000	400	25 0	4 Bearing vertical	" " " "	11
12	White River	Pac Coast Pr Co	440 ft S	2	2 000 ft	96 in to 78 in	Riveted	2	10 000	6 600	1	Francis Double discharge	20 000	360	21 0	4 Bearing horizontal	" " " "	12

*A 5th pipe and a 5th unit which differ in many details from the original installation have recently been added to this plant.

For heads above 250 ft., and particularly where the pipe-lines are long, some form of pressure regulator must be provided to lessen the rate at which the flow of water in the pipe-lines is reduced, when the load is suddenly decreased. Practice indicates that the Escher Wyss type of pressure regulator, which is essentially an inverted needle-valve, is most satisfactory. This pressure regulator automatically opens when the turbine closes and closes at a rate sufficiently slow to prevent shock. If the load fluctuations are severe the regulator can be set so as to operate synchronously with the turbine and maintain a constant flow in the pipe. The relief valve is not a limiting feature in designing Francis turbines for higher heads since they are used on heads as high as 2000 ft. in connection with other types of wheels.

Two general methods have been developed for governing impulse-wheels. A deflecting nozzle is used in which the jet is deflected from the wheel when the load decreases, and restored when the load returns. In combination with a needle-valve, by which the output of the jet may be varied at a rate sufficiently low to prevent shock, the deflecting nozzle is a very simple, safe, and satisfactory means of governing. A modification of this method consists in using a 'cut-off hood' to deflect the jet from the wheel. This plan is suitable for small wheels and low heads especially where a simple arrangement is desired. To minimize the loss of water, direct governing of the position of the needle-valve is used with some form of relief valve to reduce the shock on the pipe-line. The best form of control will depend upon local conditions. No one form will meet all requirements.

Generators.—The generators in the high-head plant are of interest in that they have to meet conditions somewhat different from those of any other plant. Experience confirms the theoretical necessity for a rotor which will be safe at the maximum runaway speed which may be attained by the water-wheel. In the case of the impulse-wheel the runaway speed approaches 100% overspeed, and the Francis turbine of low specific-speed may reach nearly 75% overspeed. It is therefore considered necessary to have the rotor so designed that no part will be stressed beyond the elastic limit at 100% overspeed. The speeds most favorable for the high-head water-wheels are of an order which gives a well-proportioned generator when the rotor is designed to be safe at 100% overspeed. In other words the rotor will be from 9 to 10 ft. in diameter at 400 revolutions per minute.

As a precaution against damage from the excessive voltage which may be generated on a runaway with full excitation, it is sometimes required that the generator windings shall withstand the voltage generated under this condition. This requirement tends to limit the normal terminal voltage to 6600 or less. Some plants have been installed with 11,000-volt generators but the most recent plants have been 6600 volts.

Longer life for the generators and more comfort for the operators are secured by enclosing the generators

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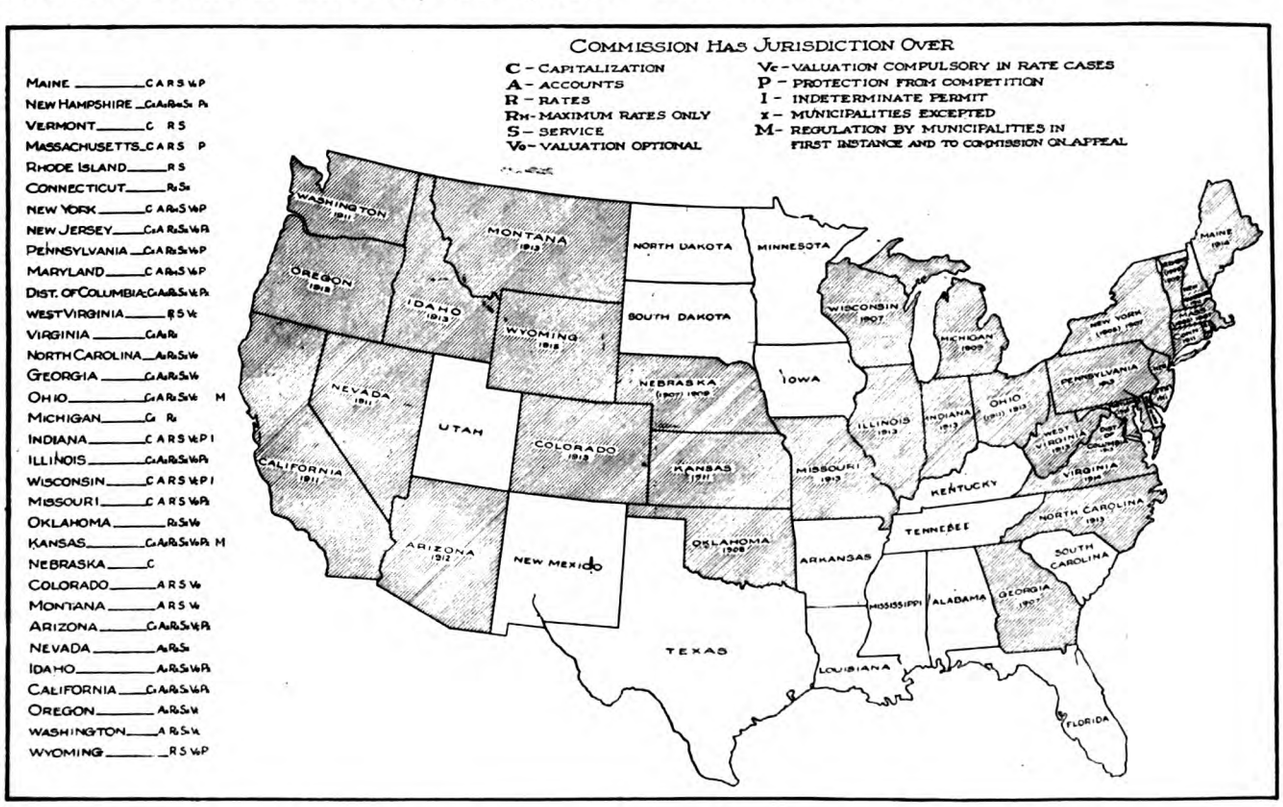
and taking the air for ventilation from outside the building. High-head plants are frequently operated under conditions which give a high load-factor, hence the heating of the generators reaches a maximum and may be sustained for days at a time. The necessity for giving special attention to ventilation in such cases is easily seen.

Practice tends strongly toward a combined water-wheel and generator-unit with a horizontal shaft and with the water-wheels over-hung on one or both ends. The simplicity, accessibility, and compactness of this type of unit make it desirable. This arrangement is naturally the most logical for impulse-wheels. Now that balancing against end thrust in the single-discharge Francis type of wheel has been accomplished, the horizontal arrangement for the turbine has no drawbacks and many advantages. A single-discharge Francis turbine for 20,000 hp. and 360 r.p.m. at 520-ft. head has been built for a unit of this type and while not yet in operation there is no doubt that its performance will be satisfactory. Where the tail-water fluctuations exceed 20 ft. and it is considered essential to so arrange the units that high water could never reach the generators even if the power-house should be flooded, the vertical arrangement of the unit is necessary when the Francis turbine is used. The overhanging of a wheel on each end of the shaft is often desirable and is necessary in many cases to obtain the desired size of unit while at the same time using the most economical speed. For operation at partial loads this arrangement is more efficient than the single-wheel unit.

General Arrangement.—The general arrangement of high-head plants is usually simple insofar as the hydraulic end is concerned. There is no difficulty in obtaining a sufficiently large output from one unit to render many units unnecessary. In fact only one of the modern plants has more than four units planned or installed. Whereas in a steam-electric plant it is necessary to have a steam engineer as well as the electricians, in the operation of a hydro-electric plant, electricians only are needed. This simplicity and economy is made possible by the simple horizontal unit which has everything on one floor where it may be conveniently watched by the switchboard attendant assisted by one or two floor-men. The accompanying table gives data on several typical high-head hydro-electric plants.

EXTENT OF REGULATION OF PUBLIC UTILITIES BY STATE COMMISSION

The accompanying map is taken from the report of the public policy committee presented before the meeting of the National Electric Light Association at San Francisco during the past month. While the map is compiled for electric light utilities, it is probable that it is approximately correct with regard to all public utilities. It will be noted that all the Pacific Coast states confer a wide range of power upon their state commissions, and that California is particularly generous in this respect. This power will be increased in August when control of public utilities within municipalities also passes into the hands of the state commission. Thus far, it has been optional with the municipality, and while many cities have voluntarily relinquished control of their public utilities, others have not done so. State control as opposed to local control was favored by many speakers at the meeting of the Association.



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Oil-Burning Stand-By Plants*

By C. H. DELANY†

It is the purpose of this paper to discuss the operation of steam plants used as stand-by in connection with hydro-electric systems, and particularly to point out some of the features wherein an oil-burning stand-by plant differs from a coal-burning plant. At the outset it may be well to mention that stand-by plants have different functions on different systems. For instance, on one hydro-electric system the stand-by plant may be used only during the period of shortness of water, which would mean that it might be operated for one or two months during the year and completely shut down the rest of the time. Another system may use its stand-by plant at frequent intervals during the year, whenever there is an interruption of the hydro-electric service lasting long enough to enable the plant to be started up. A plant of this character would have to be ready for firing up quickly on receipt of notice that it was required, and a crew of men would have to be maintained at the plant continuously for this purpose. A third class of stand-by plant may be used to insure continuity of service at all times, and kept ready to pick up the load at any instant in case of a short-circuit on the transmission-line or other slight trouble. A plant of this character must be kept operating continuously, even when it is not required to carry a load, and must be ready to pick up the load instantly on the throwing of a switch. The generating units and necessary auxiliaries must be kept going, and there must be sufficient reserve boiler-capacity cut in on the line ready to generate steam the instant the load is picked up. It is to plants of this character that I shall especially refer in this paper, and it is in plants operated in this manner that the greatest advantage is found in oil-fuel over coal.

The oil for fuel purposes on the Pacific coast usually has a gravity of from 14 to 16° Beaumé and a heating value of approximately 18,500 B. t. u. per pound. A recent analysis of a sample of oil is as follows:

Specific gravity 0.9682	= 14.60°B.
Water (by distillation)	0.95%
Flash point	239°F.
Ash	0.023%
Sulphur	0.75%
Heating value per pound of oil free from water	18,738 B.t.u.

In comparison with coal, fuel-oil not only has a higher heating value per pound, but it is possible to burn it more efficiently. It is not uncommon with oil to maintain a boiler-efficiency during plant operation approximating 80%, while coal-fired boilers in regular operation seldom show an average efficiency over 70%. One barrel of oil containing 42 gal. is thus equivalent to about 500 lb. of good semi-bituminous coal containing 14,000 B. t. u., or to approximately 650 lb. of a low-grade coal containing not over 11,000 B. t. u. per pound. At the present price of 70c. per barrel, therefore, our fuel costs are equivalent to $3.15 per ton for the best eastern coal, or $2.40 per ton for a low-grade western coal.

Oil is burned in a furnace similar to an ordinary hand-fired coal-grate, except that the grates are covered over with fire-brick with spaces between them, placed in such a position as to allow the air to enter directly under the flame at the points where it is most effective. In some cases the grates are omitted altogether and the fire-brick is supported on pipes. The oil on reaching the boiler-room is heated to a temperature of approximately 180° and is delivered to the burners at this temperature and a pressure of 40 to 50 pounds. In practically all power plants the oil is atomized by steam. While compressed air may be used for atomizing, it is found that the quantity of steam used is so slight as to make the installation of an air-compressor unprofitable. It is customary to use about three or four per cent of the steam generated for atomizing, but by proper care in heating the oil and in the design of the burners and furnace, it is possible to reduce this to less than one per cent.

By careful arrangement of the air-spaces between the brick laid on the grates, it is possible to obtain perfect combustion of fuel-oil with not over 15% excess-air, and it is due to the small amount of excess-air required that the high efficiencies are obtained. The draft required is much less than when burning coal, due to the fact that there is no draft used in pulling the air in through a thick bed of fuel. The most economical results are obtained when operating with zero-draft in the furnace, so that only enough draft is required at the base of the stack to offset the friction losses in passing through the boiler-setting and breeching. This will usually not exceed 0.3 in. even at a 200% rating, so that unless economizers are installed, a stack 100 ft. high is ample for operating a boiler up to this capacity. By operating boilers with small draft the quantity of air filtering through the brick setting is minimized, and this is another reason for the excellent efficiencies obtained when using oil-fuel.

For stand-by plants perhaps the greatest advantage in the use of oil as fuel is the rapidity with which a fire can be started. It takes only about 30 seconds to light a torch, place it in the furnace and turn on the atomizing-steam and the oil, and as soon as this is done a full fire is obtained. While the efficiency obtained is not as high as it becomes after the brickwork gets hot, it is possible to get up steam rapidly. It is not un-

*Read before the convention of the National Electric Light Association, San Francisco, June 1915.

†Steam superintendent, Pacific Gas & Electric Co., San Francisco, California.

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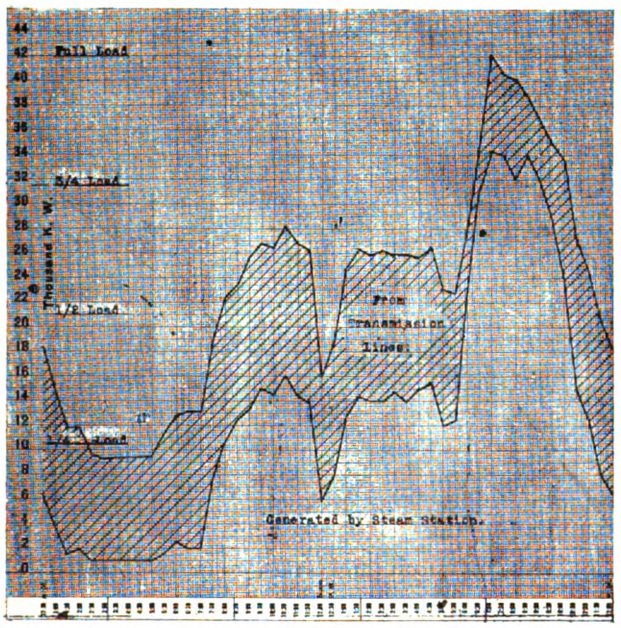
common to have a boiler that has been started with cold water ready to cut in on the line 30 minutes after lighting the fire, and in cases of emergency this has been done in 25 minutes. Another advantage which applies especially to stand-by plants is the fact that with oil fuel no banked-fires are required. When the steam is not needed the fire is simply put out and the damper shut tight; then by opening the damper and lighting the fire for a few minutes every hour, practically full boiler-pressure may be maintained. This does away with the loss due to the poor combustion of coal in a banked-fire.

One disadvantage of oil fuel in a stand-by plant that is kept shut down most of the time is the fact that it is necessary to maintain steam pressure for atomizing purposes, so as to be ready to light the fires when the plant is called upon to carry the load. This necessitates keeping steam up on one boiler continuously, and as the boilers used in modern power-plants are large,



LOAD-CURVE, SAN FRANCISCO STATION, MARCH 5, 1915.

the loss due to radiation from this boiler is considerable. This difficulty, however, can be avoided by installing a small auxiliary-boiler of five or ten horse-power capacity, which may be fired by gas, wood, or coal and which can be fired up quickly when it is necessary to put the plant into service.

In comparing an oil-fired plant with a coal-fired plant, it is well to refer to the quantity of soot deposits on the boiler tubes. There is a common belief that when burning oil, there is little or no accumulation of soot. This, however, is not the case, for while the quantity of soot is much less than in a coal-fired plant it is still an ever-present evil, and it is necessary to dust the tubes at least once a day if the best efficiency is to be obtained. It will be noted from the analysis given above, that the oil contains 0.023% of ash. While this is an infinitesimal quantity of ash compared with the amount contained in coal, it must be borne in mind that no ash whatever is taken out of the ash pit, so that all of this incombustible matter in the oil must either be deposited within the boiler setting or be carried out with the gases through the stack.

The Pacific Gas & Electric Co. is operating three stand-by steam stations at the present time, a 42,000-kw. plant in San Francisco, a 21,000-kw. plant in Oakland and a 5000-kw. plant in Sacramento. All of these are steam-turbine plants. The San Francisco plant operates continuously and is of sufficient size to carry the entire San Francisco load. It is normally operated in parallel with the transmission system and a certain number of boilers are kept standing by ready to pick up the amount of load received in San Francisco from the transmission system.

The method of operation is illustrated by the accompanying load-curve showing the conditions as they existed on March 5, 1915. The upper line in this load curve shows the total city load supplied to San Francisco; the lower line shows the amount of current generated by the steam station, and the shaded portion between these two lines shows the amount of current received from the transmission system. In case of trouble on the transmission system the entire city load would be immediately thrown on the steam station, which means that during the day the load may jump instantly from approximately 14,000 to 26,000 kw., and during the evening peak the load may jump from 34,000 to 42,000 kw. It is, therefore, essential to keep enough boilers always ready to pick up this additional load. This can be done in two ways; first, by firing only sufficient boilers to carry the actual load on the plant, operating them at a constant capacity, and keeping the remaining boilers hot, with steam up, ready to be fired instantly when necessary. Second, the full number of boilers necessary for the city load may be kept under fire continuously, operating at light load, but capable of being forced hard enough to carry the extra load when it comes on the station. The latter method requires greater care in operation to insure proper regulation of the air-supply with the wide variation of load on individual boilers, but it is more economical than the former method because a greater quantity of heating-surface is in use with approximately the same amount of radiation loss. This method, however, cannot be employed in the early morning hours when there is a load of only 400 or 500 kw. on the station and a consumption in the city of approximately 9000 kw., for it is not possible to keep sufficient boilers fired up to carry the higher load without making more steam than can be used at the extremely light loads.

Experiments show that the smallest quantity of oil that can be burned with an oil burner of the size in use at this plant is about 280 lb. per hour. If it is attempted to burn less than this the fire goes out. To insure good combustion and an even distribution of heat it is advisable to operate with not less than two burners, and consequently each boiler will generate over 200 hp. if a fire is kept under it continuously. It is,

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therefore, essential to keep a number of boilers standing by with steam up but with the fires out, whenever the load on the station is small in proportion to the load the station is expected to pick up in case of emergency.

The Oakland plant normally operates 19 hours per day with one turbine floating on the line, generating not over 100 or 200 kw. except during the peak in the evening when a load of approximately 6000 kw. is carried. In case of any minor trouble on the transmission system this station instantaneously picks up a load of about 6500 kw. and if the difficulty continues, this may within two minutes increase to 12,000 kw. The station may have to carry this load the rest of the day although in the majority of cases the trouble is immediately isolated from the rest of the system so that within two or three minutes the turbine can be switched back in parallel with the transmission system and the load dropped again to zero. There is no notice given of the load coming on, the only indication that the operators in the station have being the movement of the wattmeter needle and the steam gauge needle. This means that the wattmeter must be watched continuously so that the signal can be given to the firemen to light up their fires.

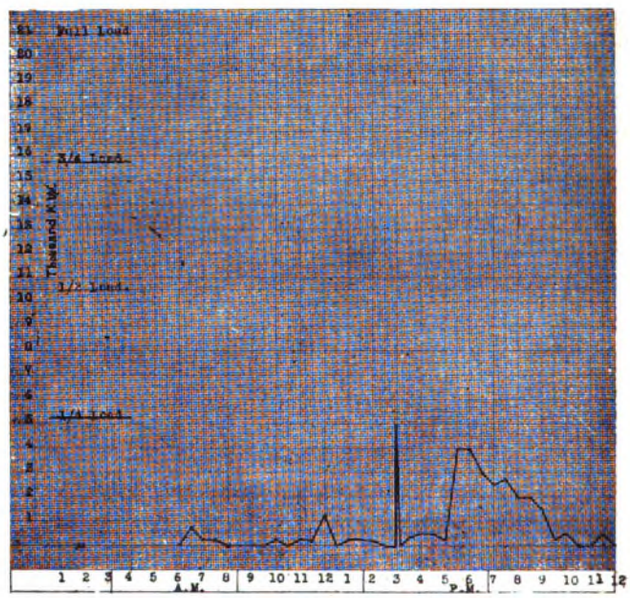
This station contains twelve boilers, eight McNaull, 750-hp., in one fireroom and four Parker, 773-hp., in the other. Ordinarily a light fire is kept under three boilers, but in order to have all boilers hot and ready to generate steam quickly as soon as the fires are started, it is customary to fire the boilers alternately; that is, three boilers are kept under fire for three hours and then three others are fired up and the fires under the first three are put out. This rotation is continued throughout the day.

As soon as the whistle blows signaling that a short-circuit has occurred, all boilers except those down for cleaning or repairs, are fired up. By careful training of the men in prompt action the entire operation of opening the dampers and ash-pit doors, lighting burners from a torch and adjusting the oil and steam valves at the burners of all boilers is accomplished in less than one minute. During this time the steam pressure often drops ten or fifteen pounds but unless an unusually heavy load is picked up, this pressure can be recovered within five minutes.

It must be borne in mind that when a disturbance on the transmission line occurs no one in the station knows whether the difficulty will last a minute or an hour, and it is therefore necessary to get all the boilers into commission at once so as to be prepared for a load of some duration. As a matter of fact, however, in the majority of cases the load remains on the station not over three or four minutes, and as soon as it goes off the fires must be put out and the dampers shut, and in many cases the safety valves blown. Tests have shown that under conditions such as described, lasting three minutes from the time the signal to light the fires is given until the fires are put out, one boiler uses 63 lb. of oil. This is equivalent to 630 lb. or nearly two barrels if ten boilers are lighted up.

The station at Sacramento is used as a stand-by station in the same manner as the Oakland station except that when a short-circuit occurs the load picked up is often nearly the full capacity of the plant. In other words, the load on this plant frequently jumps from zero to full load instantly. This plant, which contains one 5000-kw. turbine, is operated by four boilers of 823 hp. each, one of which is kept cut out for cleaning. The other three boilers are kept cut in on the line and are fired alternately so as to be kept hot.

A true idea of the conditions of operation at the Oakland and Sacramento plants can best be obtained from a study of the load-curves of the two plants. The accompanying load-curves illustrate these conditions. The load-curve for the Oakland plant for December 2, 1914, shows about a normal load for this station. The turbine started up at 6 o'clock in the morning, ran



LOAD-CURVE, OAKLAND STATION, DECEMBER 2, 1914.

along with little or no load until at 3 o'clock a short-circuit occurred which, however, lasted only a few minutes. This was the only disturbance during the day, the load dropping to zero again and remaining very small except during the evening hours. The load-curve for the Sacramento plant on the same day shows no appreciable load except at 3 o'clock when the same disturbance was felt at this plant. The disturbance appears more marked at Sacramento owing to the fact that the load picked up was greater in proportion to the size of the plant.

The load curves of these two plants for February 8, 1915, illustrate the conditions of operation during unusually stormy weather when a great many disturbances occur on the transmission lines.

In view of the unusual conditions of operation at these two plants a brief reference to some of the elements entering into the cost of operation will be of interest.

To determine the amount of fuel oil required to keep

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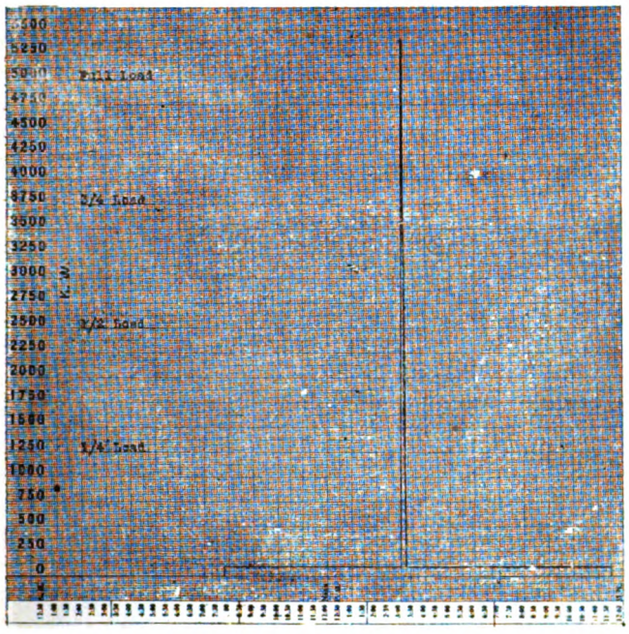
a boiler hot and ready for this stand-by service, tests were made on one McNaull and one Parker boiler at the Oakland plant. In each case the boiler was warmed up slowly with a light fire; then the fire was put out, the stop valve was shut and the boiler was allowed to stand. At the end of each hour the boiler was fired for a few minutes, long enough to bring the steam pressure back to its original pressure. The oil burned each hour was weighed and the drop in pressure noted. The following are the results:



LOAD-CURVE, SACRAMENTO PLANT, DECEMBER 2, 1914.

	750-hp. McNaull boiler.			773-hp. Parker boiler.		
	Steam pressure, lbs. per sq. in.		Oil used, lbs.	Steam pressure, lbs. per sq. in.		Oil used, lbs.
	Original.	Final.		Original.	Final.	
1st hour	188	177	32	186	190	0
2nd "	188	172	43	190	183	4
3rd "	188	169½	53	186	169	25
4th "	188	171	48	186	166	23
5th "	188	168	53	186	166	26
Average, last 3 hours...			51.3			24.6

The last three hours show fairly constant conditions in each case and their average may be taken as representative of the amount of fuel required to maintain steam pressure at over 160 lb. in the boiler, and to maintain the brickwork at a constant temperature. The figures are 51.3 lb. per hour for the McNaull and 24.6 lb. per hour for the Parker boilers, amounting to 3 and 1.4% respectively of the quantity of oil required to operate the boiler at its rated capacity. These figures compare very favorably with the figures given in the last report of the Committee on Prime Movers for the Ashley Street station in St. Louis, namely 130 lb. of coal per hour to maintain steam at 60 lb. in a boiler having 100 sq. ft. of grate surface. The marked difference between the Parker boiler and the McNaull boiler is due to the fact that while no pains were taken on the McNaull boiler to prevent leakage past the dampers, the Parker boiler is fitted with a damper that can be shut tight. This difference is borne out in the following two tests giving the amount of oil required to raise steam pressure in the boilers after the fires had been out for several hours.

	750-hp. McNaull boiler.	773-hp. Parker boiler.
(1) Boiler without fire for 7 hours before being cut off the line—then cut off the line and allowed to stand 8 hours—then fired up and brought back to line pressure. Oil used, lbs.....	514	260
(2) Boiler under fire for 3 hours with light fire—then fires put out and boiler immediately cut off the line and allowed to stand for 7 hours—then fired up and brought back to pressure. Oil used, lbs.....	336	81

The damper is a detail of boiler construction that is often neglected. While it is not a matter of much moment in a plant that is operated continuously, in a stand-by plant the tightness of the damper becomes important. This is especially true in the case of fuel oil where the damper can be shut as soon as the fire is put out.

In the normal operation of the Oakland plant, in addition to the boilers under fire there are nine boilers kept hot ready to generate steam the instant the fires are lighted. Using the above figures, 51.3 lb. per hour for each McNaull boiler and 24.6 lb. for each Parker boiler, these nine boilers use 381 lb. per hour or 7240 lb. for the 19 hours the plant is kept in operation. To this must be added about 1200 lb. to cover the warming up of these boilers after their 5-hour shut-down, making a total of 8440 lb. or 25 barrels of oil per day used solely for the purpose of keeping the extra boilers hot. This means a fuel cost of $17.50 per day to keep the stand-by plant ready to develop for full load instantly. In addition two extra men are required, so that there is an expense of $700 per month more for the instantaneous stand-by service than for a service involving only the keeping of the turbine in operation.

It is the keeping of the turbine and its auxiliaries in operation, however, that is by far the largest expense in the operation of these plants. At the Sacramento station, for instance, the records show that it takes a little less than five barrels of oil to maintain pressure on one boiler and on the steam pipes throughout the station for 24 hours. This is the total fuel-expense that would exist at this plant for stand-by service if it were possible to have one-half hour's notice of load requirements. With the turbine and auxiliaries running at practically no load (less than 200 kw.) it requires 5.6 barrels of oil per hour, which would amount to 135 barrels in 24 hours if the turbine were kept running continuously as against 5 barrels when the turbine is kept shut down. It is evident, therefore, that if it were not necessary to keep the machine in operation,

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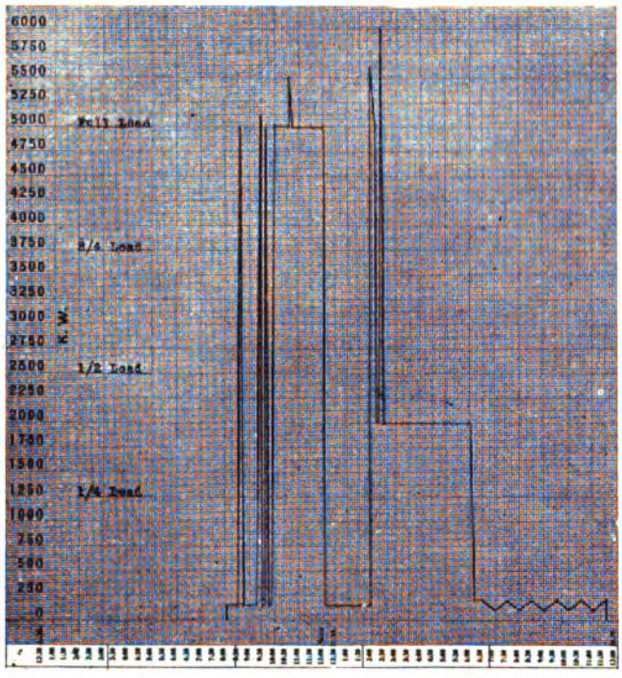
the cost of operating the plant could be greatly reduced. It is for this reason that the turbine in the Sacramento plant is operated only at such times as are considered essential for the protection of the service.

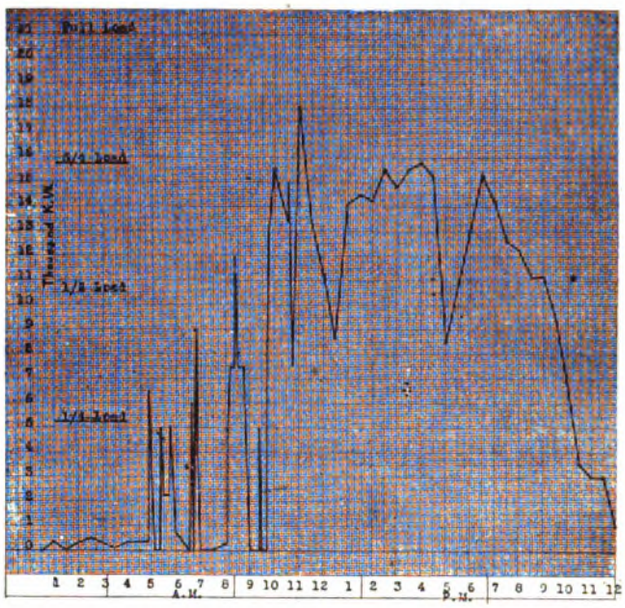
In a plant that is strictly for stand-by service, therefore, the greatest saving can be made by reducing the length of time the turbines are kept in operation. The large quantity of steam used by the auxiliaries in proportion to the amount used by the turbine at loads of 100 or 200 kw. makes it wasteful to operate turbines in this manner. It, therefore, appears that the greatest saving in the operation of stand-by steam-plants must be made by perfecting the hydro-electric transmission system so as to reduce the number of disturbances and make it entirely dependable for continuity of service. Assuming, however, that the turbines must be kept operating at speed, some economy can be effected by arranging to give the station notice of when a heavy load will be required; that is to say, if the weather conditions are such that trouble may be expected, the steam-stations should be given notice that they may be expected to carry a full load at a certain time. On other days when the weather is good, they should be notified that the load required to be picked up will not exceed a certain minimum quantity.



LOAD-CURVE, SACRAMENTO PLANT, FEBRUARY 8, 1915.

Economies that can be effected in the steam-stations themselves consist mainly in the use of apparatus suitable for this type of service. The auxiliaries should be mainly electric-driven, so far as is consistent with reliable operation, so as to prevent the waste of exhaust steam when there is not sufficient load to make use of it in the feed-water heaters. Steel casings on the boilers are especially important in stand-by plants, as when boilers are kept hot and are not generating steam, the radiation-losses are a large proportion of the total losses. Tight dampers should be installed on all boilers, and explosion-doors should be provided on the side-walls to prevent danger from a possible accumulation of gas in the setting.

Continued watchfulness in the boiler-room is essential to secure the highest efficiency. This is true in an oil-burning plant as well as in a coal-burning plant, and in a stand-by plant as well as in a plant that operates continuously. The operator is sorely tempted to neglect his boiler economies when there is very little load on the plant, because the fuel burned then is so much less than when he does carry a load, but in plants where this condition exists for 90 or 95% of the time, the stand-by losses become the real station losses, and economical operation at fractional loads becomes of prime importance.



LOAD-CURVE, OAKLAND PLANT, FEBRUARY 8, 1915.

Furnace-slag and trap rock for concrete-aggregate were recently made the subject of comparative tests by H. Perrine, of Columbia University. Compression-tests were made on eight-inch cylinders for concrete, made of one part cement, two parts sand, and four parts, either Palisades trap rock or slag furnished by the National Slag Company. The rock was separated into ¾-in., ½-in., ¼-in. sizes, and 'dust,' and then re-combined so that the grading was the same as that of the slag, which latter was used as received. The materials were proportioned by volume and mixed in a Blystone batch-mixer. When the cylinders were 28 days old they were tested to rupture. The trap-concrete developed ultimate strengths from 1769 to 2120 lb. per sq. in., averaging 1975.5 lb., while the slag-concrete developed strengths from 2275 lb. to 2750 lb., with an average of 2465.5 lb. The average weight of the trap-concrete was 154.5 lb. per cu. ft. and of the slag-concrete 140.6 pounds.—*Canadian Engineer.*

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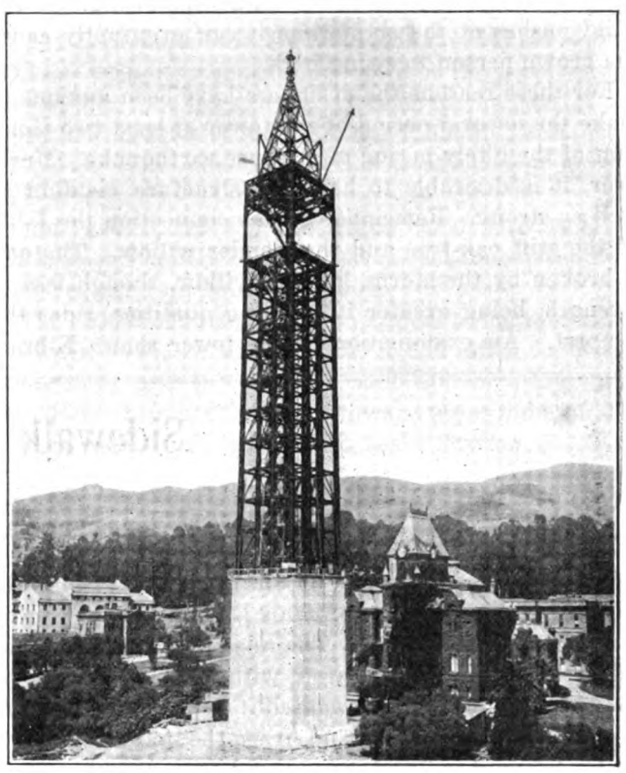
The Sather Tower*

By C. DERLETH, Jr†

The Jane K. Sather tower is a $250,000 class A structure. Structurally the design is aimed to make it of the best class A type that can be built with the present knowledge of steel-concrete construction. The average vertical distance between floor levels is twelve to thirteen feet. To the top of the belfry where the square portion of the tower ends, is 234 ft. 2 in. from the ground level. The pyramid above rises to a point supporting a huge bronze lantern whose finial is 302 ft. above the ground.

The steel structure is covered with walls, floors and roof of reinforced-concrete. The main tower is faced with granite blocks, anchored against the concrete wall-backing. In the peak the surface is marble instead of granite. The frame consists of twelve outside or main columns and four interior columns, which enclose the central elevator-shaft; all securely braced by beams and wall-trussing. The elevator runs to the level just below the belfry floor. At elevation 180 ft. there is a huge clock with four faces. The chimes are supported from a circular ring in the belfry-ceiling at elevation 220 ft. At the ground line the finished granite tower is 36 ft. square, tapering to 30 ft. square at the belfry. The steel frame extends into the ground 10 ft., where it rests upon monolithic foundations to which each column is securely anchored by four 1½-in. bolts. The monolithic slab is 8 ft. thick, 48 ft. square, contains two sets of reinforced-concrete bars meshed at right angles, and two layers of 24-in. I-beams, forming a grillage which is bolted to the steel columns. The bed of the foundation is 18 ft. below finished ground and rests on hardpan. The structural steel in this tower weighs 501 tons. The total weight of the monument on the foundation-bed is 13,750,000 lb., giving a uniform dead load pressure on the bed of the foundation of three tons per square foot. Allowing for a wind pressure of thirty pounds per square foot vertical projection decreases the pressure on the foundation at the windward toe to two tons and increases it to four tons per square foot at the leeward edge.

The structure has a large factor of safety as far as wind, dead-load, and live-load stresses are concerned. The pressure on the hardpan foundation-bed is well within safe limits; there can be no unequal settlement. The engineers paid particular attention to certain qualities of framing because of the possible effects from severe earthquakes to such a slender structure. The California earthquake of April 18, 1906, had a maximum acceleration of six feet per second. This would throw a horizontal force upon the tower of about one-fifth its own weight, the force acting against the structure in a manner similar to wind-pressure, but much more severely. An earthquake with the acceleration named, by tending to tilt the tower would produce a pressure of about nine tons per square foot at the extreme edge of the foundation, provided the structure acted as a rigid monolith. This extreme pressure, however, can never be reached because the tower is elastic and is designed to yield. The hardpan can support ten tons per square foot, and this extreme pressure could exist only for an instant, due to the oscillation of the earthquake, which would throw pressure first on one edge and then on the opposite edge of the foundation. The sub-structure and anchorage details have been designed to resist any possible uprooting of the mass or sliding or shearing at the base, such as might take place in a rigid stone-monument through the action of sudden earthquake shock. The designers have been concerned, however, more particularly with the phenomena of vibration. The natural period of the tower will be two seconds or possibly a little more. That is to say, due to the action of wind or any other horizontal pressure the tower will sway, taking two seconds to move from one extreme position to the other lateral extreme and back again. We picture here a swaying motion such as one would observe in a flag-pole, a slender tree, a chandelier or a pendulum. Earthquakes usually have a period of vibra-



THE SATHER TOWER DURING CONSTRUCTION.

*Extract from *University of California Chronicle.*

†Professor of civil engineering, University of California, Berkeley.

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tion of about one second. They tend to produce a forced oscillation in body of the same period as that of the earthquake. Now, whenever the natural period of the body and that of the earthquake differ, the two effects tend to balance or neutralize. That is why a regiment is ordered to break step when crossing a suspension-bridge. On the other hand, if a steel tower had the same period as the earthquake, both one second, the effect of the earthquake push would be accumulative. The tower would vibrate in unison with the earthquake. A condition which is described as resonance would occur. The structure would be whipped like a slender tree or flagpole in a storm, and if the earthquake only lasted long enough, the structure, no matter how well designed, must ultimately fail under the great amplitudes of the cumulative vibration. An analogy would be that of a little child pushing its father in a rope swing. If the child pushes at the right time it can eventually cause the grown person to swing high.

For these reasons the designers have been anxious to make the natural period of the tower at least two times that of the likely period of a future earthquake. Moreover, it is desirable to have the structure yielding as well as strong. Remember in this connection the fable of the stiff oak-tree and the slender willow. The oak is broken by the storm, but the willow, though less in strength, being greater in yielding qualities, rides the tempest. An examination of the tower shows X-bracing in every other story. These stories in which lateral or wind bracing is omitted give a yielding quality. In earthquake countries this is a necessary feature of high steel-towers. Where towers are X-braced throughout they must fail in earthquakes, as witness the Ferry Tower in San Francisco in 1906. Earthquakes are nature's force. They may be unlimited in their strength. When they crack the ground they may break a steel pipe as easily as a wooden fence. A great redwood tree standing on the fault line is sheared in twain; but just as easily, the crust of the earth, the very rocks, are rent for a length of three hundred miles. Such a crustal fault happened in 1906 and ran from Point Arena in the north to Hollister in the south. In other words, an earthquake will produce amounts of stress directly proportional to the resistance offered by such structures as pipes, fences, buildings, towers, redwood trees, and the rock of the earth itself.

That is why the particular form of framing described was used in the tower. The tower will yield and not resist vibration. With its large period of oscillation and these willow-like qualities of the frame we predict that the monument will withstand severe shocks. President Wheeler remarked that, from listening to the description given by the engineer, he understood that lightning-rods carried the thunderbolt from the clouds to the earth, while towers would take the rumbling out of the crust and shiver it up into the sky.

Sidewalk Construction

By JEROME B. LANDFIELD*

There is great need of better methods of sidewalk building in San Francisco. This is more or less true of other Coast cities as well. The relative unimportance of sidewalk work as compared with other branches of concrete construction has caused it to be neglected from a technical standpoint, and it is the purpose of the writer to point out and recommend some improvements in methods designed to give greater permanence, usefulness, and beauty to this part of our street equipment.

Before considering the technique of construction, let us consider sidewalk principles as they concern the good appearance of the street. It goes without saying that there should be uniformity, at least for each block, if not for each street and a city ordinance should secure this by strict specifications. Nothing makes a city look so 'down at the heel' as a variegated patchwork of sidewalk design and color.

In the residence sections of the city where the width permits, a parking space should be left on either side of the walk. Many of the finest residence streets of San Francisco are cursed with fifteen-foot sidewalks where nine feet would give all the space ever needed and allow a three-foot parking space on each side to be either graveled or sodded.

The custom of marking off little squares on the surface of the sidewalk is also detrimental to its appearance. It has been urged that these markings are advantageous, as cracks in the concrete are likely to coincide with them, but a little investigation will show this to be absurd. These markings look like imitation blocks and give a bad impression. A sidewalk should be divided into blocks not less than four or five feet square, according to its width, and these blocks should be separated by a clean-cut joint, obviating all danger of shrinkage or expansion cracks, and representing in appearance fine flagstone.

Sidewalk-building is by no means the simplest branch of concrete work, although it is so regarded by the public. There are two technical considerations involved that demand attention: first, that a sidewalk is a thin slab of concrete, subject during the setting and curing process to loss of moisture by absorption from below and evaporation from above; second, that we are dealing with the bonding of one course of concrete to another. Consideration of these facts will show that sidewalk construction should not be left to ignorant and unskilled labor. Perhaps the simplest way to attack the subject in hand is to describe what is the proper method according to the best modern practice of

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building a sidewalk, and note the principles involved in such construction.

1. The ground underneath the sidewalk should be well tamped and thoroughly wet. This will prevent the soil from robbing the concrete of its moisture.

2. Aggregate of good quality should be used. A limited amount of local bank-sand may be used but it should not be employed exclusively. The mix should not be leaner than one part of cement to seven of graded aggregate.

3. The cement must be matured. The use of fresh or 'hot' cement is a frequent cause of checked surfaces.

4. Hand mixing is preferable for sidewalk work; in machine mixing the concrete comes out too wet. California practice in hand-mixing is slovenly and inefficient. A good mixing-platform or a sheet of boiler-iron will quickly pay for itself in added efficiency. Instead of long-handled round-pointed shovels, short-handled square-pointed shovels should be used. Two men standing opposite and working in unison, turning the material over, first dry and then wet, will mix 50% more than with the usual method, with the same effort and will get better results. Water should be added with a sprinkler and never in a stream.

5. When the concrete is put into the forms, it should be well-tamped, and it should not be wet enough to quake while being tamped. This is the test of the amount of water to be used in mixing.

6. The top course should be put on while the lower course is green, preferably within half an hour. To let the lower course set first is sheer stupidity.

7. One to two is a good mix for the top course and it should not be mixed wet like mortar, the usual blunder in local practice, but stiff enough to be molded in the hand. It should then be tamped on the lower course. The object of this is two-fold. First it produces a mechanical bond. Second it brings about an even distribution of moisture throughout both courses, and removes the danger of unequal shrinkage on drying.

8. This method has many advantages. The surface may be struck off with a steel straight-edge and the tamping should bring just enough moisture to the surface for immediate finishing. In this way the cost of finishing is reduced and delays on account of too great wetness avoided. The use of a steel trowel is to be avoided, a wooden float being used instead. In this way the flushing of neat cement to the surface is prevented. The best wearing surface is formed of particles of aggregate averaging $\frac{1}{8}$ in. in diameter while a neat-cement film on top does not stand attrition and is very likely to check.

9. As soon as the finishing is completed, it is a good plan to brush the surface lightly with a wet brush, not too stiff. This takes away the objectionable glassiness and prevents slipperiness.

10. At intervals of five or six feet, according to the width of the walk, there should be clean-cut joints. These are easily made by using metal strips, which are removed while the concrete is green. These joints take care of expansion and prevent shrinkage-cracks. They also make it possible to take up and re-lay the slabs when making gas, water or other connection.

11. When the walk is completed and the surface has got its initial set, it must be protected from evaporation caused by sun and wind. To do this, cover it with wet sand and keep the sand wet. It is a common practice to cover the walk with wet sand and then let the sand dry out, which makes it a detriment instead of a help.

The method here described is a résumé of the best practice in those cities where sidewalk building has reached the highest development. By following this method, uniformity of grade, appearance and good workmanship should be attained. A wise plan followed in many eastern cities is for the city to bear one-half the cost of the sidewalk, but only in case the same is approved in all respects. It is necessary to overcome the desire for excessive cheapness. Good work costs money and walks built for nine or ten cents per square foot are certain to be inferior. Two or three cents more per square foot does not add much to the cost of the work, but materially increases the value of the abutting property. The curse of inferior workmanship is most felt where real-estate promoters in developing new property have inferior sidewalks constructed. Many of these can hardly be expected to last longer than the time required for selling the lots.

The object of this paper is to appeal to engineers and contractors for better methods, to the cities for better ordinances, and to the public at large for better taste and better prices, all looking toward a not unimportant side of city improvement and beautification.

FORTY-ONE MILES OF SEWERS FOR STOCKTON, CALIFORNIA

On June 15 last the voters of Stockton approved the proposal to issue bonds for $550,000, $350,000 for the construction of sanitary sewers, and $200,000 for storm sewers, according to plans prepared by H. T. Compton, city engineer. The sanitary sewers will include, 11,043 lin. ft. of 12-in. vitrified pipe, 13,936 lin. ft. of 16-in., 2305 lin. ft. of 18-in., 276 lin. ft. of 20-in., 5761 lin. ft. of 21-in., 21,573 lin. ft. of 24-in., 476 lin. ft. of 20-in. iron pipe, and 15,700 lin. ft. of 36-in. wood-stave pipe, together with two disposal plants. The storm sewers include 56,468 lin. ft. of 8-in. vitrified pipe, 21,327 lin. ft. of 10-in., 13,217 lin. ft. of 12-in., 8949 lin. ft. of 14-in., 10,829 lin. ft. of 16-in., 2924 lin. ft. of 18-in., 6300 lin. ft. of 21-in., 2759 lin. ft. of 24-in., 6674 lin. ft. of 27-in. concrete pipe, 1200 lin. ft. of 30-in., 1175 lin. ft. of 48-in., 760 lin. ft. of 50-in., 3152 lin. ft. of 54-in., 6650 lin. ft. of 60-in., 1166 lin. ft. of 8-in. corrugated pipe, and 3071 lin. ft. of 54-in., together with catch-basins and manholes, and two pumping stations. Specifications have not yet been completed, but will soon be ready for contractors.

Casings of starting-rheostats for motors in gassy mines must be explosion-proof, as well as the motors.

Petroleum is from the Latin, meaning rock-oil.

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Importance of Proper Inspection and Testing of Materials

By L. R. McWETHY*

When an engineer designs a structure, whether it be a building, a bridge, a dam or what not, one of his first steps is to assume working stresses for the different materials he is to use. These assumptions we may say conform to common practice as a rule. Common practice, however, is a variable quantity at best. The amount of money available in most cases will not permit of too much material and certainly the most successful engineer is the one who accomplishes the desired result with the least money. In fact this might well be used as the definition of the word, engineer.

In the case of concrete construction, for instance, with progress in manufacture, the working stresses have gradually become higher, from 300 to 500, 800 and in some cases as high as 1000 lb. per square inch. There is some doubt as to whether this tendency has not gone beyond safe limits. There is yet and always will be a certain variation in material. There is a variation in the component parts and the mixture of these parts. There is a personal factor which in many cases is important. There is the honesty of the manufacturer, which, even though it may be of the highest order, is hampered by the price at which the work was taken. Competition is keen among contractors, and the foreman knows that unless the cost is kept within the estimate he will be forced to give way to some one who can keep it so. The manufacturer may be perfectly honest, but he can not watch every detail of the work that the foreman was hired to superintend.

These and many other factors must be considered even when service is the aim of every one and the pecuniary side is overlooked. This however is by no means always the case. The manufacturer cannot insure good concrete. We must consider not only the uniformity of the cement but the gravel and other aggregates, their hardness, the amount of deleterious material, such as silt, organic matter and mica, as well as perhaps the most important consideration, the grading. In addition, there is the question of mixture, and then we must consider the contractor himself, with the possibility of great range in his methods, care, honesty, and the myriad of other factors that enter into the consideration of the problem.

What then, we may ask, is the use or advisability of all of the care used in design? To meet the situation the engineer has brought forward the ever-redeeming factor of safety, in too many cases, a factor of ignorance. The engineer's predicament is a serious one, for even one mistake may cause a great loss in reputation while the successful completion of a structure is an aid toward prominence. There is evidently the greatest need for special information and perhaps regulation and from this need has developed the testing and inspecting engineer. His duty throughout the entire building operation is to see that the materials are uniform and of the best quality as well as to study and learn the safe limits to the strength of the different materials.

It is only by the most careful testing, and the study of the results obtained, that the manufacture of different materials has developed little by little. It is due to these needs that the manufacturers of machines have developed measuring instruments from those used by the United States Bureau of Standards, which measure accurately to 1/50,000,000 of an ounce, to the testing machine with a capacity of 10,000,000 pounds.

Plainly it is not only injustice but folly to require such accurate results in the constituent materials unless we are consistent and carry it throughout the entire operation. Testing is a part of our every-day life even though we may not stop to consider it. Our food, our clothing, the cars and automobile we ride in and even the rubber bands we use on our desks are tested. It is not an expense nor a luxury, it is an absolute necessity. Why then should we 'take a chance' when a building is erected where much public and private money is expended and where many lives may be imperiled. We say they have held up in the past. True enough, but are we not demanding greater economy, forcing the architect and the engineer to lower costs, the contractor to greater competition, and the supply man to lower prices on material? Expenses are no less and each must make some profit in order to continue in business. Are we not taking too great a risk and putting a premium on dishonesty? Surely, knowledge of every step is in the direction of safety and is a wise form of insurance.

It seems to be customary among some owners, who appreciate to a certain degree the necessity of testing and inspection work, to find a firm that will do the work for the lowest price. This is natural, but in many cases such a firm should in turn have an inspector over them, for under competition the work is taken for a figure at which conscientious work can not be done. The special engineering knowledge that is required can not be obtained from those who are not informed. and if inspection is not done faithfully, it is an added expense rather than a protection.

Many contractors view inspection as a burden, but this is not true of those who have had to do with proper inspection. If the inspection firm is cheap and dishonest it is a burden, for the inspection is merely a formality from which no one benefits. For example, a building was designed for a street on a decided grade. There was no inspection. The steel for the frame work was fabricated for the wrong side of the street. This

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is a simple case to decide, but the shop had to spend time and money to make adjustments, the architect and the engineer were caused much trouble and waste of time, the contractor was delayed, and the owner was deprived of rental. Inspection surely would not have been a burden in this case. Perhaps, this is a rare instance but similar mistakes occur in places where they are not so easily detected. Careful inspection should be and is a protection to every one concerned in building operations whether the structure be small or large.

Maintenance of Earth Roads*

By GEORGE W. COOLEY†

We all know, either through our own experience or from the experience of other investigators, that the economic value of a highway depends to a great extent on its surfacing, and the care with which that surfacing is maintained. The nature of the material used for surfacing, its value as to hardness, toughness and its recementing quality is generally determined from the conditions of each individual case, but one factor remains forever the same, one rule must be continually in force, and that is a continuous and thorough system of repairs and maintenance. Without the careful carrying out of such a rule, the best roads will deteriorate, the cost of transportation will become greater with each day's neglect, and our roads will become a liability instead of an asset. By far the greater proportion of our roads, especially those in States having a large mileage and a moderate road-fund, are the common earth-roads either built entirely from the material at hand or covered when permissible, with a surfacing of gravel, sand, stone, or clay, as necessities warrant, or conditions permit. The maintenance of these roads is often totally neglected.

In the consideration of this subject, it is presumed that the fundamental principles of road construction have been followed, namely, that an ample drainage-system has been provided, and that the sub-grade or foundation has been built up without the use of perishable material. Unless our road has been so constructed, weak spots will develop and the cost of proper maintenance will become excessive. In the construction of a new earth road in an open, level or rolling country, the use of an elevating-grader is quite common. Under suitable conditions its use is justified by economy in construction work, but its value as a road-builder is lessened if, as often happens, the sod is thrown into the road-bed, and the ordinary traffic is expected to consolidate the whole mass. This can be avoided by the use of a tractor in hauling the grader, which thoroughly pulverizes and packs the material cast in by the grader. We may safely take it for granted that in any road-bed carelessly constructed with a large amount of vegetable matter, the future bills for repairs and maintenance will be in proportion to the quantity of unsuitable construction-material used. Where there has been a lax system of construction, a more elaborate system of maintenance must be adopted.

I quote the following from L. W. Page, director of the office of public roads:

"Overtopping all other road problems in its importance is that of maintenance. The destructive agencies of traffic and the elements are unceasing in their activities, and it is idle to talk of permanent roads any more than to speak of a house, a fence, or railroad ties as permanent. The public roads today, by reason of the exceptionally obstructive traffic-conditions, are more costly in construction and this cost is continually increasing with the advance in the prices of labor and material. It is criminally wasteful, therefore, to invest large sums of public money in building the highways demanded by traffic, unless the investment is conserved by adequate maintenance."

Continuous maintenance being such an important factor in the general scheme, especial effort must be made to install a satisfactory and economical system as soon as a road is opened to travel. In some of our western states, the plan has been suggested of requiring contractors on surfaced roads to provide for maintenance as soon as any section is completed, and continue the same for at least thirty days after the work is accepted, thus giving time for the engineering department to provide for the organization of a maintenance-crew without overlapping or interfering with the work of construction. In Minnesota, the plan has been adopted in the construction of earth roads to require the continual use of a drag or planer on grade-building. The latter plan has been found efficient, and renders future work on the surface less expensive, besides tending to produce a more compact road-bed. The tool found most satisfactory in this work is that known as the 'Minnesota Road Planer,' which consists of the two blades of an ordinary road-drag, fixed between a pair of runners about 14 ft. long, the blade set at an angle of about sixty degrees to the runner and made rigid or adjustable as may be deemed best. The planer is hauled on a line parallel with the axis of the road and its operation is similar to that of the ordinary drag, with the additional advantage of making a smoother surface. The old style drag without runners has a tendency, especially on new work, to increase the 'waves' or undulations frequently occurring on road construction, while the planer eliminates these faults, and as a general maintenance-tool has proved more satisfactory.

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An important feature of maintenance is prevention of the growth of sod and weeds along the traveled track. When sod is allowed to form along the highway, it has a tendency to catch the dust and debris from the road surface, and soon becomes a high tough shoulder, preventing drainage. The use of a spring-tooth harrow along the roadside two or three times a year will prevent this growth.

The State of Minnesota has given special attention to the matter of maintenance. The present road laws have made adequate provision for the care of all roads. Township and county roads constitute approximately 90% of the road mileage of the State, and of these roads, about 90% are earth roads. To care for the township and county roads, a one-mill tax is levied on all property in the township, the proceeds of which constitute the township dragging-fund. This fund is expended under the direction of an overseer, appointed by the township board, for the purchase of drags, and in dragging all roads of the town, excepting State roads. This appears to be the most satisfactory method of caring for the earth roads under the control of the local authorities, but there should be a provision in such cases, for general supervision of the work by the county highway engineer. For the care of State roads in Minnesota, 20% of the State road funds, with a due proportion of county funds, are set aside and may not be used for any other purpose than maintenance of State roads. As the State roads include all types of construction, different systems of maintenance have been required in the different localities. In general, three systems have been established: The patrol-system on macadam and well-built gravel roads, and the maintenance-section system, and road-drag system on other roads, all being under the direct supervision of the district highway engineer.

Under the patrol system, one man is assigned a section of from five to seven miles of road and works with hand tools. It has been found necessary to supplement this work with the occasional use of a team. This system has proved satisfactory on macadam and on gravel roads. Under the maintenance-section system, one man is given charge of a section of from twenty to thirty miles of road and is employed continuously with his team on the care of his section. He is given authority to employ additional help, both teams and men, and usually has two teams and four or five men at work. Contracts are also entered into by the section-foreman with residents along the road, for the dragging of same after each rain, or when ordered to do so by him. The section-crew takes care of all minor items of construction, such as placing culverts, etc., and we have found that the work when properly done, is really of a constructive nature. This system is without doubt the most effective, and is being adopted generally throughout the State. The dragging system requires the employment of a superintendent of maintenance, who for convenience should be one of the engineer's assistants. His duty is to contract or make arrangements for the dragging of all roads under his charge, and to see that the work is done at proper times. This system is suitable for slightly undulating prairie country, where most of the roads are of earth. To get best results, the superintendent should have light graders at his disposal to reshape the road-bed at least at the beginning of each season.

On earth or gravel roads, no maintenance system is complete which does not contemplate the use of planers or similar devices, and a combination of work as outlined under the section system is recommended.

Comment on 'The Accumulation of Petroleum Near the Outcrop of Oil Sands'

By DORSEY HAGER

Mr. Leon J. Pepperberg's article, 'The Accumulation of Petroleum near the Outcrop of Oil Sands,' page 463, in the May 1915 issue of WESTERN ENGINEERING, brings out a point that is very important for operators and engineers to know.

Mr. Pepperberg contends that the light oils with paraffine bases predominating do not form commercial accumulations near the out-crop, as the oil is driven from the sands due to infiltrating water, capillarity, etc. With heavy asphaltic oils a seal of asphalt forms at the face of the sand, and checks the escape of further oil. With the light oils, which lack the material to form an effectual seal, accumulation does not take place.

Mr. Pepperberg's point is well taken. His evidence is based on Wyoming conditions, yet Oklahoma evidence bears out the same point. In spite of the extent of the oil deposits in northeastern Oklahoma, seepages are rare. Indeed, a seepage is a great curiosity, although all the oil sands show outcrops. Many wells located near the outcrop but several miles down the dip have failed to give any commercial oil. Even many favorable folds near the outcrops fail to give commercial productions.

Indeed the point Mr. Pepperberg raises is so important in Oklahoma that I have consistently turned down folds, which lie five and six miles from the outcropping sands, except where deeper sands might be productive. Mr. Pepperberg has presented an important point, and one with which I fully agree.

Costs of street repairs in Chicago have been reduced by the municipal asphalt plant. During 1913 asphalt pavements were repaired at a cost of 81.1c. per sq. yd., or 87.1c. per sq. yd., allowing for plant depreciation and interest on investment. At a total cost of $62,637.03, or $1.175 per sq. yd, 53,342 sq. yd. of brick pavements were repaired. Granite block pavements to the extent of 59,345 sq. yd. were repaired at 53.2c. per sq. yd., or a total of $31,593.04. Macadam pavements cost 12.16c. per sq. yd., 1,880,365 sq. yd. having been repaired at a cost of $227,443.03. Of cedar block pavements 2595 sq. yd. were repaired at a cost of $524.49, or 20.25c. per square yard.—*Municipal Record.*

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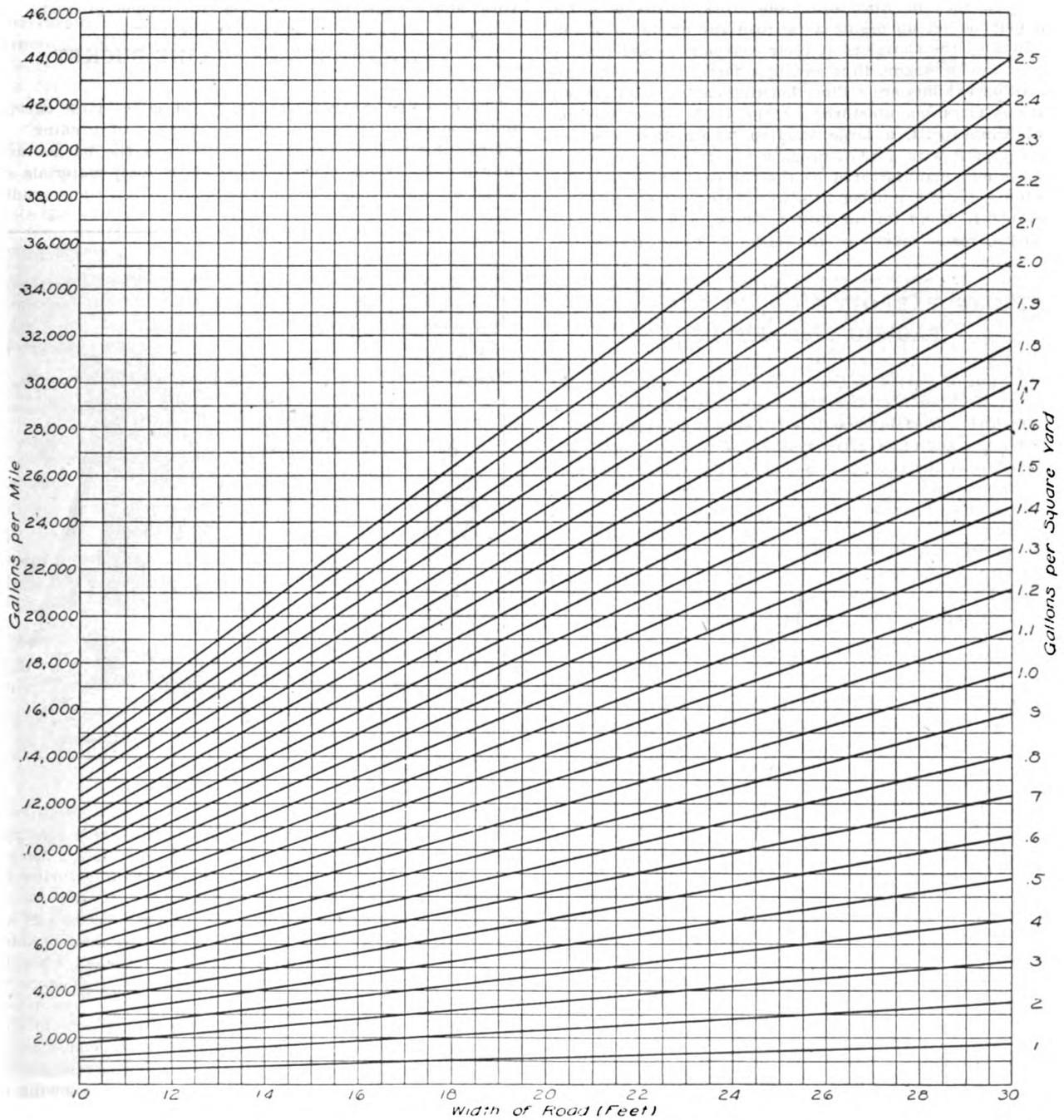
Engineers' Note Book

DIAGRAM FOR FIGURING ROAD-OIL REQUIRED FOR DIFFERENT CONDITIONS

The following diagram, taken from a booklet on 'Paving and Road Construction,' published by the Union Oil Company of California, will be found of value in figuring on road improvements. To use the diagram, from the determined width of roadway follow vertically to the intersection with the inclined line representing gallons per square yard. From this intersection follow horizontally to the left side of the chart, and read off the corresponding number of gallons per mile.

Thus with a 20-ft. roadbed, and six-tenths of a gallon of oil used per square yard, we have 7000 gallons needed per mile of road.



Industrial Progress

EXHIBIT OF THE A. L. YOUNG MACHINERY CO. AT THE PANAMA-PACIFIC EXPOSITION

In the exhibit of the A. L. Young Machinery Co. in the Palace of Machinery, a number of the concerns for whom the company acts as agent are well represented.

The Waterloo Cement Machinery Corporation, of Waterloo, Iowa, is represented by two Wonder concrete mixers and a 'Double Quick' trench filler. The mixers have a capacity of ½ cu. yd. and ⅜ cu. yd., respectively, and are mounted on the same truck with the gasoline engine for running them. They may be equipped either with or without a side loader. By means of the side loader, one batch can be made ready while the previous batch is being mixed, thus practically doubling

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the output on ordinary work. The trench filler comprises a small gasoline engine and winding drum mounted on a turntable on a light truck, which can be placed on one side of an excavated trench, and used to operate a scraper for filling the trench. The machine moves forward under its own power by means of a line attached to a 'dead man' ahead.

The Kelly-Springfield Road Roller Co., of Springfield, Ohio, exhibits two steam rollers of the familiar type, one 7-ton and one 10-ton, and asphalt. They also show a two-cylinder gasoline roller. Attached to this is a road scarifier. Chas. Hvaas & Co., of New York, is represented by a number of machines for street-cleaning and other street work, including a pick-up sweeper, a combination sweeper and sprinkler equipped with a rubber squegee broom, a sand spreader and asphalt distributer, and asphalt heater, and a number of other smaller machines.

Nearby is a dump wagon manufactured by the Watson Wagon Co., of Canastota, New York. In connection with this is shown a Rapid Loader, manufactured by the Bonney Supply Co., Inc., of Rochester, New York. This is a bin which may be set up beside a railroad car or dump of any kind, filled by the shovelers at their convenience and instantly tipped into a wagon, thus saving a large amount of team time. Other exhibits are a Flory hoisting engine, road graders of various sizes manufactured by the Glide Road Machine Co., of Minneapolis, a large traction 'Chain Belt' concrete mixer equipped with a 20-ft. boom, a collection of woodworking machinery manufactured by the Crescent Machinery Co., of Leetonia, Ohio, a number of sewer cleaning tools made by the Harold L. Bond Co., of Boston, Mass., and a planer for bituminous roads made by the Headley Good Roads Co., Philadelphia.

EXHIBIT OF PARROTT & CO., AT THE PANAMA-PACIFIC EXPOSITION

The exhibit of Parrott & Co. in the southeast corner of the Palace of Machinery at the Panama-Pacific Exposition contains much that is of interest to engineers and contractors, in the machinery and other articles exhibited by the various concerns for which the Company is agent. Building contractors will be interested in the New York Patent Safety Scaffolds. Besides being an improvement over home-made scaffolding in the matter of convenience and economy, these patent scaffolds comply strictly with the California law recently passed and dealing with this subject.

The St. Louis Steel Foundry of St. Louis is represented by a number of railway frogs, switches and other track specials. The Owen Bucket Co., of Cleveland, Ohio exhibits two clamshell dredge buckets. The wall back of these exhibits in constructed of Denison interlocking tile made by the Denison Block Co., of Sacramento. Specimens of the tile are also shown. The C. H. & E. Manufacturing Co., of Milwaukee exhibits several machines, including a mortar mixer, a bilge pump, portable saw rig, and a piston force pump mounted on the same truck with the electric motor that drives it.

Another interesting exhibit is an ornamental concrete fountain which has been waterproofed with Ceresit, a compound manufactured by the Ceresit Waterproofing Co., of Chicago. The Russell Grader Manufacturing Co., of Minneapolis exhibits several road graders and dump wagons. The Iroquois line of road rollers, manufactured by the Barber Asphalt Co., is represented by a 12-ton macadam steam roller, and a 5-ton tandem roller for use on asphalt pavement.

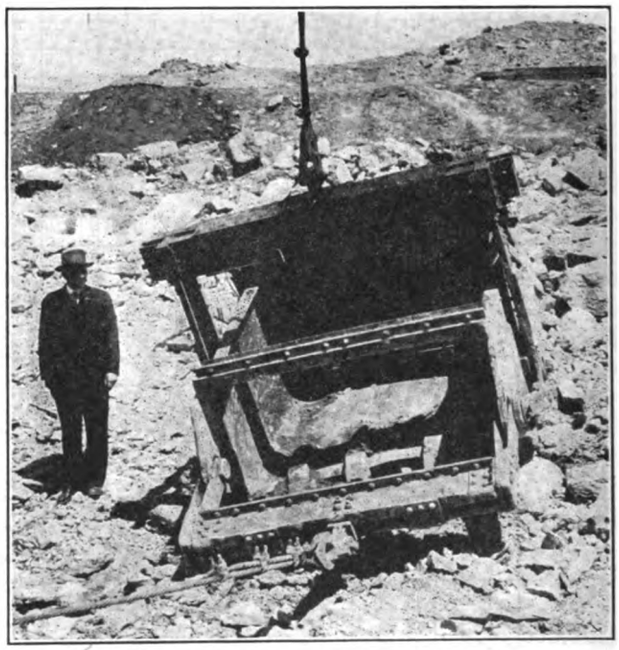
The exhibit of the Clyde Iron Works, of Duluth is composed mainly of hoisting equipment. Two swing hoists are shown, one driven by steam and the other by an electric motor. There is also a common double drum hoisting engine and a three drum engine. A large variety of hoisting blocks of various sizes are on exhibition. There is also a model of a field-tower drag-line excavator, the lines being arranged on the miniature bucket so that the action of the machine itself may be readily understood.

The T. L. Smith Co. of Milwaukee is represented by a complete line of concrete mixers from a small machine with a capacity of 2½ cu. ft. per batch, designed to be wheeled about and operated by hand, up to the large Chicago Paver, fitted with an 18-ft. distributing chute. One of these machines recently laid 21,000 sq. ft. of four-inch pavement in an 8-hr. day, using a crew of 18 men. To meet the demand for a machine suitable for the entire work of laying an asphalt pavement, they have on exhibition a 'Hot Mixer,' that may be used in the ordinary way for laying the concrete base of a pavement and then the drum may be heated and the mixer used for preparing the asphalt wearing surface.

Other interesting exhibits are an air-compressor and motor made by the Curtis Manufacturing Co. of St. Louis, a full line of chains, hooks, etc., made by the Columbus Chain Co. of Columbus, a chute for handling package goods in stores and warehouses made by the Haslett Spiral Chute Co. of New York, and a collection of the Genasco roofing products.

THE SHNABLE DRAG-LINE BUCKET

The drag-line excavator is recognized as the most effective and economical machine for many classes of grading. Its successful operation depends largely upon the bucket used. Only a well-designed bucket made of the best materials can 'stand up' under the conditions encountered on many grading jobs. To meet the demand for a bucket which will give good service under adverse conditions, the Brown Hoisting Machinery Company, of Cleveland, Ohio, is now manufacturing the Shnable Bucket. This is a back-dumping bucket, and consists of a shell, a pulling bail, and a combination hoisting-bail and back-gate. The pulling-bail is connected to the shell at points which are above the centre of gravity of the shell when the bucket is in its digging position. The pulling-bail is connected with the hoisting-bail and back-gate by means of links in such a way that tension on the drag-line forces the gate to close and to remain closed. When the bucket is suspended on the hoisting-bail and the tension on the drag-line is released, the back of the shell drops away from the back-gate allowing the load to slide and drop out. This construction obviates the



THE SHNABLE DRAG-LINE BUCKET.

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necessity of a tripping or locking device on the bucket. The pulling bail is connected to the shell by bronze sliding-blocks carried in slots in the shell. By means of these slots, the required motion to permit the bucket to dump when the tension on the drag-line is released is given to the link-connections between the pulling-bail and the back-gate. The bucket is operated by a drag-line and a hoist-line.

Two important advantages are obtained by dumping the bucket from the back. First, none of the load while being dumped, can strike the lines or any part of the bucket. Second, by making use of the centrifugal force acquired by the machine while rotating, the load can be dumped at a slightly greater radius than the radius of the machine. The arrangement of the lines on the bucket allow of its working down a slope without changing the position of the lines, and also makes it possible to use the machine for fine work such as trimming slopes.

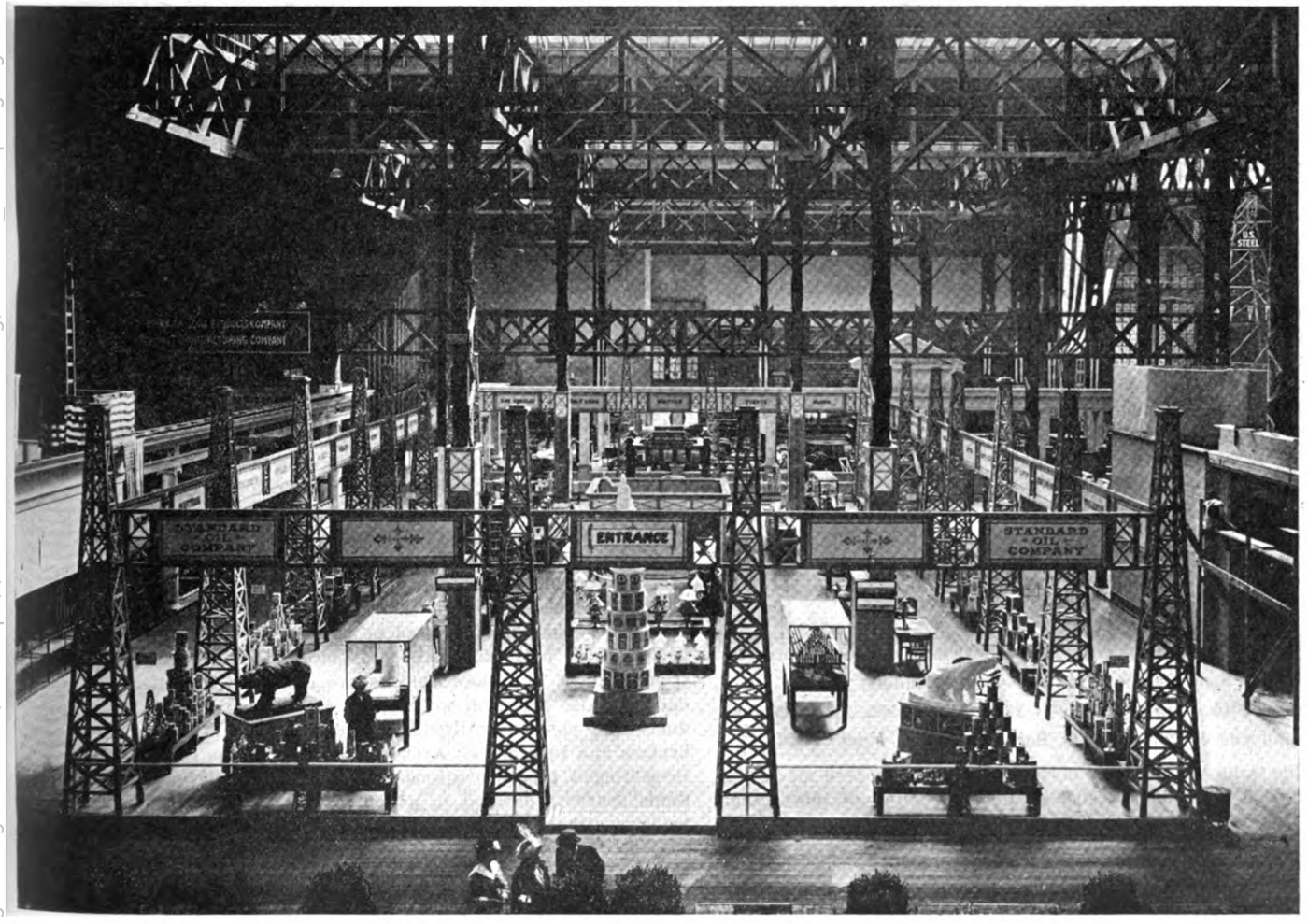
The parts of the bucket that receive the greatest wear, namely, the front section of the shell, the cutting plate, the teeth, and the teeth points, are all made removable so that they can be renewed separately. The entire bucket is of simple construction and can be readily repaired in the field. Buckets of this type have been used on the Chicago Drainage Canal system for the past five years, excavating glacial drift and solid rock with satisfactory results.

EXHIBIT OF STANDARD OIL COMPANY AT THE PANAMA-PACIFIC EXPOSITION

While the Standard Oil Company is represented in the California building and in the Palace of Transportation, the principal exhibits of the Company of interest to engineers are in the Palace of Mines and Palace of Machinery. The latter exhibit is mainly devoted to lubrication. A marine gas engine, a cream separator, and a steam turbine are all shown running and are lubricated in the most approved manner. The upper half of the turbine-case has been removed and a glass covering substituted, allowing an examination of the working parts. Samples of petroleum products are also shown, arranged by gravity from the asphaltums and greases, through the liquid lubricants, to engine distillate and gasoline. Different oil-burning devices are also shown.

The main exhibit of the company is in the Palace of Mines. The exhibit space is enclosed in a sort of fence composed of models of the derricks of famous wells. Upon entering, the visitor's attention is directed to a row of cubes showing the ingredients and proportions for the principal asphaltic pavement surfaces, such as asphaltic concrete, sheet asphalt, and topeka specification pavement. A cube of cement concrete and a specimen of brick pavement laid with petrolastic cement are also shown. There are also sections of road with different kinds of pavement, together with samples of Calol asphaltum and petrolastic cement.

Geological and surface conditions in the Midway oilfields are shown in a large model of the famous Section 36, near Taft, California. Another model is circular and shows miniature wells actually pumping oil while all around the model is a panorama of the Midway field as a whole. A similar model shows the company's refinery at Richmond, California. A number of fossils from oil-producing and adjacent formations are shown, some of them being arranged for examination under the microscope. A more practical side of oil production



STANDARD OIL COMPANY EXHIBIT IN PALACE OF MINES.

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is shown in a glass model illustrating the application of the air-lift principle to oil-well pumping. A stripped automobile chassis with the engine running illustrates the most approved methods of automobile lubrication. Other parts of the exhibit show oil transportation by models of tank steamers, tank cars and wagons, and there are many commercial devices for different uses in oil-consumption as well as maps and graphic charts of production.

Hints on Practice

BLASTING HINTS

In loading any kind of borehole, it is advisable to insist on the loader cleaning the hole to the bottom. All sludge and mud from the drills should be pumped or blown out. Air spaces anywhere in the blast-hole also reduce the work done by the explosive. A loader who is not careful to fill all the air spaces is likely to be an expensive man to his employers. In loading with dynamite cartridges, where it is necessary to fill air spaces, each cartridge should be slit lengthwise with a knife. One cut is as effective as two or three when the tamping-stick is pressed against the cartridge, and the powder is not smeared along the sides of the borehole as much as when the cartridge is slit a number of times, as is frequently done in ordinary practice.

In deep well-drill holes, it is advisable to place a primer with an electric blasting-cap every 15 ft. in the load. This is not only insurance against expensive misfires, but makes for more perfect detonation of the entire charge, greater efficiency, and increased economy. Remember, however, that a blasting-machine is limited as to the number of electric blasting-caps that it will fire, and that it should not be overloaded on any account.

In loading 'lifters,' or holes drilled horizontally, or nearly so, and especially when they are 'sprung,' it is advisable to have a loading-tube, made of zinc or galvanized iron, as large as will go into the hole, and then load the explosive through this, withdrawing it as the charge rises. Where the loading-tube is not used, a bamboo fishing-pole makes an effective loading-stick, as the small end can be used as a needle on which one cartridge at a time may be stuck, placed in the bottom of the hole, and shaken off. The pole is then reversed and the charge packed in carefully with the large end. Bamboo tamping-sticks have the advantage of being very light, straight, and inexpensive. The loader can charge more holes with a bamboo stick without getting tired than he can with a heavy oak, hickory, or other hardwood stick, and, in addition, it is safer to have a light tamping stick than one with which the loader can strike the explosive a heavy blow.—*Du Pont Magazine.*

Book Reviews

LATHES: THEIR CONSTRUCTION AND OPERATION. By George W. Burley. Scott, Greenwood, & Son, London and D. Van Nostrand Co., New York. P. 228. Ill., index. For Sale by *Mining and Scientific Press*, San Francisco. Price, $1.25.

The lathe is one of the most important of modern machines, for on it depends the successful construction of most other machinery. After a brief, historical review of the subject, the present volume takes up the different classes of modern lathes, namely, hand-turning, engine, turret, vertical and special lathes. The general characteristics and field of use of the different types are considered and there are a number of illustrations showing the principal kinds of each type of lathe. A chapter is devoted to such lathe accessories as chucks, mandrels, etc., and their uses explained. The subject of lathe tools is discussed in connection with tool steels and some space is also given to the questions of feed and cutting speed. Another chapter is devoted to lathe-work in general. The appendix contains tables of gear-wheel combinations for cutting different screw-threads. While the treatment throughout is entirely practical, the underlying principles involved are considered, and the book will be of value to the student as well as to the practical machinist.

MATERIALS OF CONSTRUCTION. By Adelbert P. Mills. P. 658. Ill., index. John Wiley & Sons, Inc., New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $4.50.

This work is primarily a text-book, but, notwithstanding the necessarily brief treatment that must be given to each subject, has also considerable value as a book of general reference. The materials of masonry construction are first considered, the chapter headings being Gypsum Plasters, Quicklime, Hydrated Lime, Puzzolan Cements, Natural Cements, Portland Cement, and Concrete. The production, properties, and uses of each material are briefly discussed. Stone and then brick masonry are then considered, the latter subject including special kinds of brick, terra cotta, and tile. Iron and steel are naturally given the largest space in the book. Methods of manufacture of the different grades of iron and steel are discussed and considerable space devoted to the effect of different proportions of carbon and other foreign substances on the properties of the finished product. In this and also in several succeeding chapters these effects are shown graphically in a number of diagrams. A chapter is devoted to the various special alloy-steels for which the needs of certain modern machinery has created a demand. The different non-ferrous metals that are of importance in construction, together with their alloys, are briefly considered. The last chapter of the book is devoted to timber, the data contained being mainly abstracted from the many government publications on the subject. While the volume as a whole contains little that has not already been said in other books, yet it is several years since all this information has been collected under one cover, and in the meantime, considerable progress has been made both in the production and the use of many structural materials. The book is well illustrated and there are a number of useful tables and diagrams included in the text.

DESIGN OF STEEL BRIDGES. By F. C. Kunz. P. 461. Ill., index, and 52 plates. McGraw-Hill Book Co., Inc., New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $5.

This volume is intended more as a reference and hand-book for the practising engineer than a textbook for the student, although the theoretical foundation for design is considered as well as practical details. The first chapters take up the forces acting on a bridge, and then stresses in trusses and in the bracing of simple spans is considered. The various types of bridges are classified and their principal characteristics described. A chapter is devoted to floor-design, both of railroad and highway bridges. Beam and plate-girder bridges, simple truss bridges, and skew bridges are discussed in order, and data are also given on weights of simple span bridges. Viaducts and elevated railroads are discussed, and then draw-bridges and turntables. Arch-bridges both of the two and the three-hinged type are discussed, and also cantilever bridges. Some space is devoted to a general discussion of long-span bridges, although suspension bridges are not thoroughly discussed. The appendix contains some tables and other useful information, and there are 52 full-page plates, most of them showing details of bridges actually constructed. There are also a number of valuable tables and diagrams scattered through the main body of the text.

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Construction News Summary

PRESENT STATUS OF ENGINEERING PROJECTS ON THE PACIFIC COAST

(Engineers and others connected with construction work are invited to make use of these columns to acquaint other members of the profession and the general public with the progress of work under their charge.)

PROJECTS OF UNITED STATES RECLAMATION SERVICE

SALT RIVER PROJECT, ARIZONA—Except for completion of sixth unit of Roosevelt power-plant, work on the entire project is practically finished. When this plant is completed, the project will be on an operation and maintenance basis. C. H. Fitch, project manager.

MINIDOKA PROJECT, IDAHO—Laterals on 'B-1' extension under construction; 'G-20' and 'J-40' extensions completed. Boersch lake drainage pumping station nearly completed. Remainder of work on project practically completed. H. M. Schilling, project manager.

UMATILLA PROJECT, OREGON—About 39,000 cu. yd. excavated on main canal of west extension. On main canal, 12,000 lin. ft. has been lined with concrete 3 in. thick, about 2000 cu. yd. in all. All work on force account. H. D. Newell, project manager.

BOISE RIVER STORAGE UNIT, IDAHO—Arrowrock dam practically completed with 180,000 acre-feet of water now in storage which is being drawn upon for irrigation. Lining of spillway trench completed and spillway lip 50% completed. C. H. Paul, constructing engineer.

SHOSHONE PROJECT, WYOMING—Drainage work in progress. Lidgerwood drag-line excavator is being used to deepen Bitter creek, and an Austin trencher digging trenches for closed tile-drains. All work by government forces. G. O. Sanford, project manager.

TRUCKEE-CARSON PROJECT, NEVADA—Lahontan dam completed and force dismissed in June. Other construction work will not be taken up until irrigable area is settled to a greater extent. D. W. Cole, project manager.

GOVERNMENT RAILROAD IN ALASKA

Construction commenced at several points near Ship Creek. Materials being landed and wagon-roads being built.

GENERAL CONSTRUCTION IN WASHINGTON

STATE HIGHWAY—Contracts awarded during June for 35 miles of road costing $166,000.

GENERAL CONSTRUCTION IN OREGON

MULTNOMAH COUNTY HIGHWAYS—Contracts awarded for 65 miles of permanent highways costing $1,160,000 and work commenced about June 22. John B. Yeon is roadmaster. Warren Construction Co., Boyajohn-Arnold Co., and Montague-O'Reilly Co., of Portland, and Clark & Henery Construction Co., of Sacramento, California, are contractors.

OREGON CITY—Trenching for South Fork water project practically completed and 50% of pipe on ground, ready for laying. H. A. Rands is engineer and Oregon Engineering & Construction Co., contractors.

COOS BAY—Government dredge 'P. S. Mitchie' has removed 180,000 cu. yd. material from the harbor bar during June. J. H. Polhemus is engineer in charge.

GENERAL CONSTRUCTION IN CALIFORNIA

GOVERNMENT WORK ON SACRAMENTO RIVER—One dredge working near Rio Vista, removing 152,000 cu. yd. material during month of May.

STATE HIGHWAY—Contracts awarded during June for 31 miles of road costing, including materials furnished by state, $234,000. Bids will be received in July for construction of 55 miles of road.

KINGS COUNTY HIGHWAYS—Bonds for $672,500 have been sold and bids will soon be received.

ORANGE COUNTY HIGHWAYS—Contracts have been awarded for 115 miles of road, 111 miles has been graded, concrete has been laid on 93 miles, and 95 miles have been completed, the plans not calling for concrete on all roads. S. H. Finley is chief engineer and George R. Wells, office engineer.

Bonds for $480,000 have been voted in the Anderson-Cottonwood irrigation district. Southern Pacific Co. has force at work repairing Colusa and Hamilton City branch, which was washed out last winter. Municipal tunnel at Richmond will be completed about July 3. Shattuck-Edinger Co., contractors. A large part of rock-fill for municipal wharf is in place. Healy-Tibbetts Construction Co., contractors. Haviland & Tibbetts, engineers. On Shell Oil Co. pipe-line, Sanderson & Porter report that they have laid and tested 127 miles of the line and that several of the stations are in operation.

STATE HARBOR WORK AT SAN FRANCISCO—Pier 24 was completed during June. Healy-Tibbetts Construction Co., contractors. The bulkhead wharf for piers 18-20 was completed and the Belt railroad connected to pier 18. San Francisco Bridge Co., contractors. A building for the American Express Co. is now under construction by state forces. The post-office building is being constructed by Teichert & Ambrose. Healy-Tibbetts Construction Co. are building pier 35, the bulkhead building on pier 37, side-aprons on ferry-slips 6, 7, and 8, and an extension to pier 20. Jerome Newman, chief engineer.

GENERAL CONSTRUCTION IN ARIZONA

Mascot & Western Railroad between Willcox and the Mascot copper mines, a distance of 18 miles, has been completed.

General Summary

Condensed From Our Daily Construction News Service.

CALIFORNIA

ALAMO—Voters of Alamo and Moraga precincts have decided to establish Mount Diablo boulevard district. Road 30 miles long and costing $120,000 will be constructed. Following commissioners were elected, Arthur Burton, Edward Williams, and Josiah Boucher, of Moraga, Tassajara, and Alamo, respectively.

ANGELS CAMP—G. Oneto is interested in project to divert water of Stanislaus river at Reynolds Ferry and mine the riverbed.

AUBURN—Contract for construction of Coon Creek bridge has been awarded to Jenkins & Wells, Sacramento, for $4888. ——Herdal Bros. were low bidders at $20,832 for construction of Masonic Hall building.

BAKERSFIELD—Contract for paving 20th street has been awarded to Thompson Bros., Fresno, for 12c. per sq. ft. for grading and paving, 15c. per ft. for gutters, and 35c. per ft. for curbing.——Contract for improving 25th street has been awarded to Wetzel & Larsen, for 3c. per sq. ft. for grading and oiling, 15c. per ft. for gutters, and 35c. per ft. for curbs.——Board of Supervisors will receive bids until July 7 for construction of section 3, division 5 of Bakersfield-McKittrick highway.——Bids will be received until July 8 by I. L. Miller, county clerk, for furnishing 30,000 tons of crushed rock, 16,000 tons to be delivered at Wasco and 14,000 tons at Bowerbank.——Contract for furnishing 90,000 bbl. of cement for county highway work has been awarded to Pacific Portland Cement Co., Pacific Bdg., San Francisco, for prices ranging from $2.43 to $2 63 per barrel according to point of delivery.——Weringer Mines Co. will build copper reduction plant at its mines at Woody. Joseph Weringer is president.——City is considering purchase of street planer. Wallace Morgan is city manager.——Contract for construction of 4.2 miles of road between Bakersfield and Mojave, has been awarded to William J. Cahill, for $18,901.76 ——City council is considering electrolier system for business district.

BERKELEY—Contract for construction of branch library in West Berkeley has been awarded to J. Wendering, 1911 Addison avenue.——Council is receiving bids for construction of school building on Telegraph avenue costing $90,000.

BURLINGAME—Contract for construction of ten bridges has been awarded to Eaton & Smith, 11th and Harrison streets, San Francisco, for $20,072.22.——Contract for construction of pavement on Cypress, Occidental, Barroilhet avenues has been awarded to Raisch Improvement Co., Crocker Bdg., San Francisco.

CALEXICO—All bids for street paving and storm drains ex-

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ceeded the engineer's estimates considerably and were rejected. Work will probably be re-advertised.

CHICO—Citizens are considering municipal street-lighting system.

COLLEGE PARK—Contract for construction of dining hall for College of Pacific has been awarded to Johnson Co., San Francisco, for $8786.

COLTON—California Portland Cement Co. will spend $150,000 on additions to rock-crushing plant.

COLUSA—Contract for construction of eight bridges has been awarded to Peter Gracer, Williams, for $9600. Contract for construction of four other bridges has been awarded to W. B. Esterly, for $2462.

EL MONTE—Milton Kauffman is sub-dividing 60-acre tract and will improve streets with oil macadam and concrete curbs. R. L. Wood is engineer.——Contract for improving Main street has been awarded to M. W. McCombs, 516 Bryson Bdg., Los Angeles, for $17,700.——Contract for improving Center street has been awarded to Bingham & Pendleton, Hermosa Beach.——Contract for improving Columbia street has been awarded to J. M. Montgomery Construction Co., Alhambra.

ESCONDIDO—Escondido Mutual Water Co. is considering construction of hydro-electric plant costing $85,000. H. Hawgood, San Diego, is chief engineer.

EUREKA—Contract for grading Henderson street has been awarded to John Devoy, for $4424.

FRESNO—City clerk is receiving bids for furnishing light tractor for street work.——Board of supervisors has appointed highway commission. They will employ an engineer to report on county highway system. It is probable that a bond issue for $3,000,000 will be voted in October.

GRIDLEY—Contract for 15 blocks of street pavement has been awarded to Clark & Henery Construction Co, Sacramento, for $52,373.40. Pavement will have 4-in. concrete base and the cost will be 18.2c. per sq. ft.——City trustees have decided to have plans and specifications prepared for building for Carnegie library.

HANFORD—Bonds for $672,500 for system of county highways have been sold to a banking syndicate and bids for construction of first units of system will soon be called for.

HAYWARD—City is considering purchase of water system and making extensions. Manuel Riggs is fire chief.

HOLLISTER—Hollister Water Co. is in the market for 1000 lin. ft. of 4-in. cast-iron pipe and 2500 lin. ft. of 6-in., also 20 gate-valves. W. N. Bruce is superintendent.——Contract recently awarded for paving Monterey and Sixth streets has been invalidated because of legal technicality and bids will be re-advertised.

HUNTINGTON BEACH—Contract for construction of school has been awarded to Harvey Garber, Orange, for $40,694.——Contract for improving Huntington avenue has been awarded to G. A. Considine, 1547 Central avenue, Los Angeles.

LONG BEACH—Contract for construction of reinforced concrete pier has been awarded to S. M. Kerns, 625 West Ocean View avenue, for $47,800.——Contract for improving Marine way has been awarded to Fairchild-Gilmore-Wilton Co, Pacific Electric Bdg., Los Angeles, for 17.8c. per sq. ft. for paving.

LOS ANGELES—City cement plant at Monolith has been leased to Los Angeles county for four years at a yearly rental of $27,500.——Harbor commission is receiving bids for extension of First street at San Pedro, involving considerable excavation.——State Supreme Court has decided in favor of the validity of the $6,500,000 power-bond issue, thus removing all obstacles to their being sold.——Harbor engineer S. A. Jubb is preparing plans for $300,000 concrete warehouse at municipal dock No. 1.——Contract for improving Manhattan place has been awarded to George R. Curtis, 552 South St. Louis street, for $20,190.48.——Contract for improvment of roads in district No. 34 has been assigned to J. A. and A. A. Merrill, 3562 Van Ness avenue. Contract price was $33,335.——Contract for macadam pavement on La Ballona road has been awarded to Rogers Bros. Co., 350 Merrick street, for $8071.20.——Contract for pressed steel posts and wiring in Culver City district has been awarded to F. E. Newbery Electric Co., 724 South Olive street, for $16,375 ——California-Arizona Construction Co., Brockman Bdg., has been awarded the following contracts: improving Bay street, for $7527.36; improving Ingraham street, for $11,549.60; improving Santa Monica boulevard, for $124,280.02.——Wattson & Spicer, Wright & Callender Bdg., have been awarded contract for improving Westmoreland avenue for $13,063.90, and contract for improving Prince street for $1875.94.——E. A. Simmons, 3931 Pasadena avenue, has been awarded contract for improving Echo Park avenue for $3024.85.——R. S. Matthews, Sherman, has been awarded contract for improvements in road district No. 62, for $15,380.——Naftzger & Howard, 828 Union Oil Bdg., have been awarded contract for improving Olive street for $12,884 72.——Contract for improving Avenue 57 has been awarded to George R. Curtis, 552 South St. Louis street for $1384.46.——Contract for construction of Gallatin school has been awarded to J. H. Linkletter, Whittier, for $8300.——Contract for construction of Buchanan street school has been awarded to B. D. Kronnick, 3901 South Hill street, for $21,640.——Contract for construction of 42nd street school has been awarded to Merchants Realty & Investment Co., Van Nuys Bdg., for $23,200.——Contract for construction of Clifford street school has been awarded to Somers-Lund Co., 1415 Baker-Detwiler Bdg., for $37,868.——Contract for construction of Willowbrook school has been awarded to W. L. North, Willowbrook, for $14,512.——Contract for macadamizing 2.32 miles of San Bernardino road has been awarded to P. A. and C. H. Howard, 2821 Sacramento street, for $14,485.——Contract for improving Le Moyne street has been awarded to E. A. Simmons for $6433.32.——Contract for improving Malabar street has been awarded to George R. Curtis, 552 South St. Louis street, for $10,261.——Contract for construction of sewer on Washington street has been awarded to Adam Dalmatin, 475 South Savannah street, for $10,460.——Contract for construction of Owensmouth high school, has been awarded to C. W. Kent & Son, 429 South Brand boulevard, Glendale, for $63,806.——Contract for construction of Franklin high school has been awarded to Los Angeles Planing Mill Co., 1812 Industrial street, for $134,616.——Plans for widening and grading First street have been adopted. Cuts as deep as 26 ft. will be necessary.——Contract for construction of Budlong avenue school has been awarded to Alex Grant, Builders Exchange, for $41,533.——Contract for construction of Vermont avenue intermediate school has been awarded to Los Angeles Planing Mill Co., 1800 Industrial street, for $95,987.——Contract for construction of brick and concrete building for Clifford street school has been awarded to Somers-Lund Co., 1415 Baker-Detwiler Bdg., for $37,868.——Contract for improving Kingsley drive has been awarded to George R. Curtis, 552 South St. Louis street, for $8902.——Contract for construction of buildings at Hyde Park grammar school has been awarded to H. M. Boward & Sons Co., 247 South Flower street, for $43,862.——Contract for improving 7th street has been awarded to H. C. Withers, Builders Exchange, for $3966.78.——General Petroleum Co. has rescinded contract awarded to Leonardt & Peck for concrete oil-reservoir at San Pedro and will construct same by day labor. R. Maynard, Higgins Bdg., is chief engineer.——Contract for improving Ardmore avenue has been awarded to California-Arizona Construction Co., Brockman Bdg., for $9692.70.——Contract for improving Medford street has been awarded to Bryant & Austin, 1650 Compton avenue, for $13,132.90.——Contract for macadamizing roads in district No. 68 has been awarded to P. A. and C. H. Howard, 2821 Sacramento street, for $14,485.——Contract for improving 15th street has been awarded to Fairchild-Gilmore-Wilton Co., Pacific Electric Bdg., for $20,437.80

MANHATTAN BEACH—Contract for improving Pacific avenue has been awarded to J. D. Kneen, Dudley Bdg., Santa Monica.——Contract for improving Manhattan avenue has been awarded to Municipal Improvement Co., Berry Bdg., Richmond.

MARTINEZ—Board of supervisors has adopted plan for building 100 miles of permanent highway at the rate of about 11 miles per year. Work will be paid for out of general tax levy.——City engineer has been authorized to prepare plans and specifications for water system. Estimated cost, $50,000.

MARYSVILLE—Contract for construction of gold dredge for Yuba Consolidated Goldfields Co. has been awarded to Yuba Construction Co.; dredge will cost $600,000 and will be the largest in the world.——Board of supervisors will soon advertise for bids for construction of three reinforced concrete bridges on state highway. Total length of bridges, 400 ft. L. B. Crook is county surveyor.——Contract for fencing along state highway has been awarded to Charles H. Groh, for 82c. per rod for fence and $9.50 for gates.

MERCED—Bond issue for $1,000,000 for county highway system has been proposed. John R. Graham is chairman of committee. Petition for election will probably be presented to supervisors soon.

MODESTO—Plans for Gasburg crossing have been adopted by directors of Modesto irrigation district. Three plans have been submitted, one for an earth fill with concrete culvert, one for part earth fill and part flume on concrete arch, and the third for concrete arches all the way. Estimated cost $70,000. F. C. Herrmann, Merchant's Exchange Bdg., San Francisco, is chief engineer.——City council has authorized Lowell Gumm to purchase 32 gas street-lamps.

NAPA—Contract for street paving has been awarded to George Errington for $6221.

NEVADA CITY—City council has decided to build two concrete bridges as soon as funds are provided.

OAKDALE—Directors of Waterford and Modesto irrigation districts have completed arrangements by which the Waterford district will obtain water from the Modesto district. Construction of works will be started soon. F. C. Herrmann, Merchant's Exchange Bdg., San Francisco, is chief engineer for the Modesto district.

OAKLAND—Contract for construction of concrete foundation for county infirmary has been awarded to Clinton Fireproofing

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Co., Mutual Bank Bdg., San Francisco.——Bids will be received until 10 a m., July 19, by G. E. Gross, county clerk, for construction of two-story concrete and frame building for Alameda County juvenile court and detention home.——Southern Pacific Co. will erect ten-story depot-building at 14th and Franklin streets.

ONTARIO—Bids will probably be received in August for improvement of Euclid avenue, involving 350,000 sq. ft. concrete pavement with asphaltic oil top, 152,000 sq. ft. macadam, 56,000 sq. ft. concrete gutters, 58,000 sq. ft. cement and cobblestone gutters. Estimated cost, $65,000. B. B. Mann is city engineer.

ORANGE—Bids will be received until 9 a.m., July 6, by C. W. Hallman, city clerk, for construction of concrete bridge across Santiago creek. Plans from county surveyor, Santa Ana, upon deposit of $5.

OROVILLE—City trustees have ordered plans and specifications prepared for paving Montgomery street. Contract was awarded for this improvement recently but later the whole proceedings were rescinded.——Contract for construction of Bangor school house has been awarded to C. H. Hemstock, for $1587. ——State highway commission has authorized survey for highway through Feather River canyon.——Proposed drainage district in Richvale region was found to contain some land in Glenn county so board of supervisors took no action on petition for formation of district. Petition will be amended so as to exclude the Glenn county land.

PALO ALTO—Contract for sewer construction has been awarded to California Pottery Co., 12th and West Mission streets, San Francisco.

PASADENA—Contract for improving Pasadena avenue and Walnut street has been awarded to Andrew Holloway, 451 South Broadway, for 18c. per sq. ft., for 2-in. bitulithic wearing surface on 4-in. concrete base, or $17,930 in all.——Contract for construction of Linda Vista water system has been awarded to T. L. Syvertson for $19,617.34.——Contract for improving Oak street has been awarded to Thomas C. Breitenstein, 405 Douglas street, for $1813.80.

PETALUMA—Pacific Gas & Electric Co. will replace five miles of high pressure main. Estimated cost is $12,000.

PORTERSVILLE—Contract for construction of school at Pleasant View has been awarded to Graham & Buckmaster, Exeter, for $3900.——Council has decided to pave Belleview avenue. I. H. Althouse is city engineer.——Contract for construction of 1½ miles of 12-in. cement pipe, for J. F. Wetherby, has been awarded to Concrete Pipe & Construction Co.——Bids will be received until 10 a.m. July 8, by F. W. Griffin, First National Bank Bdg., for construction of building for Rockford school district.——Sunset Construction Co., Lick Bdg., San Francisco was low bidder and will probably be awarded the contract for paving several streets. Its bid was 12.83c. per sq. ft. for pavement composed of 4-in. concrete base and 1½-in. asphaltic wearing surface, and 1c. per sq. ft. for grading.

RED BLUFF—Board of supervisors is receiving bids for construction of remaining bridges on state highway.——Pumping plant and distribution system will be constructed on Blossom ranch. Estimated cost is $20,000.

REDDING—Board of supervisors has adopted plans for steel bridges across Clover and Clear creeks.——Board of supervisors has directed county surveyor to prepare plans for bridge across Sacramento river at Kennett. Bridge will probably have four steel spans, each 160 ft., with concrete piers and approaches. Estimated cost is $20,000.——Bonds for $480,000 for construction of irrigation system have been voted in Anderson-Cottonwood irrigation district.——Board of supervisors has decided to remove dams on Hat creek and repair other damage resulting from recent eruption of Mt. Lassen. C. E. Mott will be in charge of work. Estimated cost $1700.

REDWOOD CITY—Following contracts for highway work have been awarded: to Blanchard-Brown Co., 661 Market street, San Francisco, 8.9 miles, at $31,367; to James Willison, 6 miles at $25,665; to Wrightson, Anderson & Yost, 4.2 miles, at $28,558. ——Supervisors have appropriated the following amounts for highway work: road from Pescadero to Santa Cruz county line, $28,809, road near Holy Cross cemetery, $14,414, Lobitos road, $2880 92.

RICHMOND—Contract for paving Cutting boulevard has been transferred to Ransome-Crummey Co., First Savings Bank Bdg., Oakland. Contract price is about $90,000.——Contract for two blocks of paving has been awarded to E. H. Higgins, 720 Fourth street, for $4909.72.——Castro Point Railway & Terminal Co. has applied to Railroad Commission for permission to issue $89,000 in stock, proceeds to be used for extending line along waterfront for two miles.——Atchison, Topeka & Santa Fe railroad will construct steel viaduct on 7th street.

RIO VISTA—First National Bank will build reinforced concrete building, costing $20,000. Bids are being received by W. H. Weeks, 75 Post street, San Francisco.

RIVERBANK—Contract for construction of lighting system has been awarded to Pacific Fire Extinguisher Co., 507 Montgomery street, San Francisco, for $4,185.

ROSEVILLE—Standard Oil Co. will build distributing station costing $20,000.

RIVERSIDE—Contract for improving Vine street has been awarded to Shull, Tucker & Co. for $8140.98.

SACRAMENTO—Governor Johnson has signed bill which will facilitate co-operation between the Federal Reclamation Service and the State in the construction of engineering works. This bill was introduced primarily in the interests of the Iron Canyon project near Redding.——Pacific Gas & Electric Co. will make following improvements to its street-railway system: reconstructing 2486 ft. of track on P street, replacing 3920 ft. of track on J street with 87-lb. groove rail, replacing 1721 ft. of track on Stockton avenue and Park avenue with 87-lb. groove rail.——Following bids have been received for state highway work: in Tulare county, Division VI, Route 10, Section A, Taylor & Berliner, Los Angeles, $24,957.20, W. A. Dontanville, Paso Robles, $20,378.50, George S. Benson & Sons, Stimpson Bdg., Los Angeles, $17,628.50; engineer's estimate $16,499.05; all bids rejected. In Monterey county, Division V, Route 2, Section B, W. A. Dontanville, $20,340.50, Manuel Jacinto, Sacramento, $26,250, Lou G. Hare, Salinas, $22,733, C. H. and A. W. Gorrill, Call Bdg., San Francisco, $28,828.50, James Fitzpatrick, Sacramento, $28,889.75, Peterson & Grier, San Francisco, $23,380.75, Hoffman & McLaren, Oakland, $28,409.75, engineer's estimate $29,777.53; contract awarded to W. A. Dontanville. In Colusa county, Division III, Route 7, Section C, W. B. Hunt & Sons, Alameda, $42,242.20, Taylor & Berliner, $42,002, Commary-Peterson Co., Inc., 742 Market street, San Francisco, $43,859.50, L. F. Gerdetz, Rialto Bdg., San Francisco, $40,052, Bent Bros., Los Angeles, $53,487.70, James Fitzpatrick, $42,722, Marin Rock Co., San Anselmo, $41,548, C. H. and A. W. Gorrill, $41,489.50; engineer's estimate, $48,857.18; bids taken under advisement. In Humboldt county, Division I, Route 1, Section E, W. B. Hunt & Sons, $69,316.80, Frank L. Smith Co., Eureka, $68,607.10, Bates, Borland & Ayer, Oakland Bank of Savings Bdg., Oakland, $55,061.10, A. C. McLean Construction Co., 320 Market street, $71,063, L. F. Gerdetz, $54,399, Twohy Bros. Co., First National Bank Bdg., San Francisco, $72,865.30, Hoffman & McLaren, $55,789.80, Fairbanks & Baechtel, Willits, $60,376.20, James Fitzpatrick, $66,764.60, Mercer-Fraser Co., Eureka, $65,806.30, G. W. Connors, Eureka, $60,080.90, F. Rolandi, 550 Montgomery street, San Francisco, $77,729.70, W. A. Bechtel, Alton, $70,147, A. Robinson and R. R. Smith, Fortuna, $65,012.52, Crowley, Cloney & Green, Eureka, $75,772.40; engineer's estimate, $65,728.83. Contract awarded to Bates, Borland & Ayer. In Tehama county, Division II, Route 3, Section C, Eaton & Smith, 11th and Harrison streets, San Francisco, $54,987.50, G. W. Conners, Eureka, $57,950, W. B. Hunt & Co., Alameda, $59,323.50, Twohy Bros. Co., First National Bank Bdg., San Francisco, $70,252 60, Richard Rothwell, 1107 Westlake avenue, Los Angeles, $68,498.40, F. Rolandi, 550 Montgomery street, San Francisco, $66,169.30, Toohey & Johnson, Phoenix, Arizona, $63,772.30, Bates, Borland & Ayer, Oakland Bank of Savings Bdg., $60,282.50, Hoffman & McLaren, Oakland, $51,733.20, H. H. and T. W. Harlan, Williams, $49,990.70, L. F. Gerdetz, Rialto Bdg., San Francisco, $56,873, James Fitzpatrick, Sacramento, $50,206, Commary-Peterson Co., 742 Market street, $72,065; engineer's estimate $43,559.01. In Tehama county, Division II, Route 3, Section B., Commary-Peterson Co., $44,662, G. W. Conners, $57,823, Twohy Bros. Co., $47,197.60, George Vogelsang, Tehama, $83,760.80, Marin Rock Co., San Anselmo, $52,851.10, Manuel Jacinto, Sacramento, $51,482, Bates, Borland & Ayer, $49,795, Hoffman & McLaren, Oakland, $43,657, C. H. and A. W. Gorrill, Call Bdg., San Francisco, $46,390.80, L. F. Gerdetz, $46,040, James Fitzpatrick, $45,914.50; engineer's estimate, $43,277.95. In Los Angeles county, Division VII, Route 4, Section A., Leigh Garnsey, Los Angeles, $27,956.50, George Wiegand, Lamanda Park, $24,280.10, H. R. Kennedy & Frank Williams, 771 Catalina street, Los Angeles, $21,100.70, White & Gaskill, Long Beach, $26,643, John D. Marsh, Bakersfield, $25,552.20, W. A. Dontanville, Paso Robles, $23,918.10; engineer's estimate, $26,893.55. Bridge in Yolo county, Ross Construction Co., $24,906, Seabury B. Peterson, San Francisco, $37,984, Graff Construction Co., Crary Bdg., Seattle, Wash., $35,900; engineer's estimate, $21,818.03. In Kings county, Bent Bros., Los Angeles, $69,555.50, Taylor & Berliner, Los Angeles, $56,808.80, George S. Benson & Sons, Stimpson Bdg., Los Angeles, $50,211.90, John D. Marsh, Bakersfield, $51,697, W. A. Dontanville, $54,954.80; engineer's estimate, $51,261.60.——Contract for construction of state highway from Saugus to Castaic, 4.2 miles, has been awarded to H. R. Kennedy and Frank Williams, 771 Catalina street, Los Angeles, for $21,100.70.——Contract for construction of high school at Fair Oaks has been awarded to Campbell & Turner for $32,364.——Contract for improving alley between K and L streets has been awarded to McGillivray Construction Company.——State enginner W. F. McClure will call for bids for construction of additions to Preston School of Industry at Ione, costing $31,000, and for remodeling State Normal School at San Francisco, costing $12,000.——Contract for construction of state highway between Proberta and Red Bluff has been awarded to Hoffman & McLaren, Oakland, for

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$43,657.——Contract for construction of state highway between King City and Greenville, 7.3 miles of concrete pavement, has been awarded to Highway Paving & Construction Co., 26 Montgomery street, San Francisco, for $51,393.25.——Contract for improving alley between J and K streets has been awarded to Henry Dehn.——Contract for improving Bancroft way has been awarded to Clark & Henery Construction Company.——Contract for improvement of Dana way has been awarded to Clark & Henery Construction Company.——Contract for improvement of Clark avenue has been awarded to Clark & Henery Construction Company.——State Highway Commission will receive bids until July 6 for the following work: in Tehama county from Red Bluff to northerly boundary of county, 12.7 miles to be graded, in Glenn county from Willows to Grapit, 9.4 miles to be paved with concrete, in Contra Costa county from Tormey to Eckley, 3.5 miles to be graded, in Tulare county from Goshen to Visalia, 6.4 miles to be paved with concrete, and from westerly boundary to Goshen, 3.9 miles to be paved with concrete. The work in Tehama county has already been advertised, but the first bids were rejected because too high.——McGillivray Construction Company was low bidder for paving U street at 13.4c. per sq. ft. for asphalt.——Contract for construction of 10½ miles of state highway from Colusa Junction to northern boundary of Colusa county has been awarded to L. F. Gerdetz, Rialto Bdg., San Francisco, for $40,052; materials furnished by the state costing $52,622.68.——Contract for construction of nine miles of state highway from Hanford to eastern boundary of Kings county has been awarded to George S. Benson & Sons, Stimpson Bdg., Los Angeles, for $50,211.90; materials furnished by state, costing $43,097.70.——All bids for construction of highway from Atascadero creek to Paso Robles were rejected and new bids called for.——State highway commission will soon call for bids for construction of bridge at Dunsmuir, over Sacramento river, and bridge at Baird over Pit river.——Contract for construction of part of trunk-line sewer has been awarded to Matthews Construction Co. for $42,460.——Contract for construction of unit No. 2 of trunk-line sewer will probably be awarded to Clinton Fireproofing Co., Mutual Bank Bdg., San Francisco, at $92,192. Engineer's estimate, $110,000.

SALINAS—Contract for construction of six-span bridge across Salinas river at Nacimento has been awarded to W. L. Gillan, for $27,730.——Contract for construction of four-span steel bridge over Salinas river at Neponset has been awarded to Peterson & Grier, San Francisco, for $32,290.——Contract for highway construction has been awarded to Granite Rock Company for $12,286.

SAN BERNARDINO—Contract for improving I street has been awarded to Highway Construction Company for $15,380.34, including 10c. per sq. ft. for 4-in. concrete paving with oiled screening surface.——Contract for improving Second street has been awarded to Tuttle & Deyoe for 9.7c. per sq. ft. for 4-in. concrete paving with oiled screening surface, or $12,236.28 in all.

SAN DIEGO—Contract for construction of sewer and water system at naval radio station has been awarded to Power Equipment Commpany, Rialto Bdg., San Francisco, for $10,650.——Contract for paving Broadway with asphalt between California and Atlantic streets has been awarded to Fairchild-Gilmore-Wilton Co., Pacific Electric Bdg., Los Angeles.——Contract for construction of 2¼ miles of Mission Beach boulevard has been awarded to Pioneer Truck Company.——University Club will erect club-house. George W. Marston is member of committee. Estimated cost, $30,000.——Contract for construction of 6-in. sewer on Adams avenue has been awarded to Doran & Reed, for $2630.

SAN FRANCISCO—Following street work has been ordered: vitrified brick pavement, granite curbs, and sidewalks on Pacific avenue; curbs, sidewalks, and asphalt pavement on Balboa street; curbs, asphalt pavement, sidewalks, and sewers on Parnassus avenue; curbs and basalt block and asphalt pavement on 13th avenue; sewers on Prentiss street; curbs and basalt and asphalt pavement on Spruce street; curbs, sidewalks, and asphalt pavement on 14th street, Lida place, and Elm street.——Contract for furnishing lighting fixtures for engine house No. 12 has been awarded to Thomas Day Company, 725 Mission street.——Following street work has been ordered: curbs, sidewalks, catch-basins, and asphalt pavement on 19th avenue, grading, curbs, sidewalks, sewers, and broken rock pavement on Vermont street, basalt and asphalt pavement on Wool street.——Contract for construction of sidewalks in front of Golden Gate park has been awarded to F. J. Dowling & Company, Russ Bdg., for 9c. per sq. ft.——Contract for construction of curbing and pavement on 14th avenue has been awarded to Owen McHugh, Russ Bdg., for $7896.——Contract for construction of pavement and sewers on San Bruno avenue has been awarded to City Street Improvement Company, 166 Geary street, for $35,000.——Contract for construction of pavement on Wisconsin street has been awarded to Eaton & Smith, 11th and Harrison streets, for $13,333.——Board of public works is receiving bids for furnishing lighting fixtures for city hall. Estimated cost, $60,000. Bids are also being received for paving on 14th street, estimated cost, $9800 and for sidewalks on Fulton street, estimated cost, $6800.——Board of works has adopted plans for scenic boulevard around Twin Peaks. Roadway will be paved with asphalt.——City engineer M. M. O'Shaughnessy has prepared plans for extension of municipal railway across Golden Gate park. Estimated cost, $200,000.——Following street work has been ordered: grading and construction of sewers on Girard street, sewers on Hale and on Merrill streets, curbs, catch-basins, culverts, sidewalks, and asphalt pavement on 26th street, grading and construction of sewers on Quesada avenue.——Contract for construction of iron fence around Hamilton playground has been awarded to San Francisco Iron Works, 45 Shotwell street, for $2855.——Following contracts have been awarded for building juvenile detention home on West Mission street: general contract to Pacific Construction Company, 16 California street, for $91,325, structural steel to Dyer Bros., 17th and Kansas street, excavation and foundation to J. Spargo, 926 Presidio avenue, for $4400, plumbing to H. Lawson, 344 Fourth avenue, for $14,350.——Bids will be received until 10 a.m., July 9, by L. H. Rand, 405 Custom House, for leasing to United States and operating one clam-shell dredge on the Sacramento river. About 50,000 cu. yd. of material is to be removed. General and detailed specifications are on file at office of **Western Engineering.**——Constructing quartermaster has awarded contract for construction of macadam road from Lobos creek to Battery Chamberlain to Sunset Construction Company, Lick Bdg., for $16,554. Contract for construction of concrete road from marine hospital has been awarded to D. L. Bienfield & Co., Phelan Bdg., for $9372.——Contract for furnishing creosoted piles has been awarded to J. M. Coleman for $15,605.——Board of public works has awarded contract for construction of cubical system at isolation hospital to Monson Bros., 1907 Bryant street, for $7900.——Pacific Gas & Electric Company will make following improvements to its system: 8-in. lap-welded high-pressure gas main from Potrero to county line, 31,500 ft. long, two 822-hp. boilers and superheaters at station A, 93 gas lamp-posts.——Board of supervisors has ordered filling of Quint street at Islais creek. Estimated cost $18,000.——State harbor board has been authorized to proceed with the preparation of specifications for reconstruction of pier No. 11. Estimated cost, $25,000.——Thomson Bridge Company, 103 Main street, was low bidder for construction of foundations and superstructure for bascule bridge at 4th street at $84,287. California Construction Company, New Call Bdg., was low bidder for superstructure alone at $43,000.——Construction & Engineering Company, Hobart Bdg., was low bidder at $32,800 for building another story on Geary street car-barn.——Board of public works will receive bids until July 7 for boilers and piping for Polytechnic high school. Estimated cost, $12,000.——Fay Construction Company was low bidder at about $12,000 for paving San Bruno avenue.

SAN JOSE—Bids will be received until 11 a.m., July 12, by H. A. Pfister, county clerk, for construction of reinforced concrete bridges on Quito and Pollard roads.——County has decided to purchase $35,000 worth of state highway bonds to assist completion of highway to Los Gatos.——All bids received for furnishing 50,000 bbl. of cement to county were exactly the same, ranging from $2.40 to $2.63 per bbl. according to point of delivery, and they were all rejected and new bids will be called for.——Contract for improving sections A and C of Alviso road has been awarded to Casley & Hamilton for $13,331.19 and $7602.95 respectively. Contract for improving section B has been awarded to J. W. McReynolds for $7067.21.——Board of supervisors has extended time for receiving bids for construction of reinforced concrete bridges over Permanente creek, Calabasas creek, San Tomas creek, and Campbell creek until 11 am., July 6.——Property-owners on West Santa Clara street have decided on a three-light electrolier made by Joshua Hendy Iron Works, 75 Fremont street, San Francisco, and costing $58 each.——Contract for improving Hull avenue has been awarded to M. Montoya and M. Winkelback at 30c. per lin. ft. for curbing, 15c. per sq. ft. for gutters, and 3c. per sq. ft. for grading and graveling.——Chamber of Commerce is considering proposed system of county highways. W. S. Clayton is chairman of committee.

SAN JUAN—Citizens are considering bond issue for $6000 for street pavements.

SAN LUIS OBISPO—Board of supervisors will receive bids until 10 a.m., July 8, for construction of reinforced concrete bridge of 20-ft. span four miles from city, and one 108-ft. riveted-truss and seventeen 34-ft. concrete spans seven miles from city. Both bridges on state highway. A. F. Parsons is county surveyor.——Contract for construction of concrete oil reservoir for Union Oil Company has been awarded to Allison & Cole Construction Company.

SANTA ANA—Contract for construction of El Toro road has been awarded to Max L. Hubermann for 35c. per cu. yd. for ex-

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cavation, 11c. per lin. ft. for shaping road-bed, $10 per cu. yd. for class A concrete, $1.86 per cu. yd. for class B concrete, and 5c. per lb. for reinforcing steel, a total of $2992.——Bids will be received until 2 p.m., July 7, by W. B. Williams, county clerk, for furnishing not less than 50,000 nor more than 80,000 bbl. of cement to county.

SANTA BARBARA—Contract for construction of improvements on Anacapa street has been awarded to L. L. Pendola for $9011.86.——Contract for construction of three miles of road in Montecito has been awarded to J. A. Clarey for $45,000.——Contract for construction of De La Vina-Haley Street bridge has been awarded to Boardman Construction Co., Los Angeles, for $6760.——Bids are being received by A. C. Holmberg, city clerk, for construction of bridge at Mission street.——Contract for construction of Donze avenue sewer has been awarded to A. A. Lemmon.——Contract for construction of 6-in. sewer on Figueroa street and on San Pascual street has been awarded to A. A. Lemmon.——Contract for construction of sidewalk along boulevard has been awarded to Munoz & Munoz, Central Bdg., Los Angeles, for $5600.

SANTA CRUZ—Contract for building road to Big Basin has been awarded to W. J. Reynolds, San Jose, for $4750.——Contract for construction of concrete dam on San Lorenzo creek near King City for Chris Widemann has been awarded to Nelson Mosher for $80,000. Dam will be 300 ft. long and about 50 ft. high.

SANTA ROSA—Contract for grading and macadamizing Brown street has been awarded to W. H. Locke for $2000.——Contract for furnishing 3000 cu. yd. crushed rock has been awarded to P. Maroni at $1.60 for No. 1 and 2 grades, $1.35 for No. 3 and 4, and $1.45 for crusher run.——Contract for furnishing fuel oil has been awarded to Lee Bros. for $1.26 per bbl.——Residents of Valley Ford district have petitioned for construction of new road and bridge over Estero Americano creek. M. P. Youker is county surveyor.——Street commissioner Beebe is receiving bids for laying concrete curbs and gutters on Washington street and on A street. He will also lay sewer and water mains on Brown street.——Contract for paving part of Santa Rosa avenue with asphaltic concrete has been awarded to City Street Improvement Company, 166 Geary street, San Francisco, for 15½c. per sq. ft.——Federal government has granted permission for construction of bridge at Black Point. Supervisor Harry Weise will proceed with construction of Black Point road.——Contract for construction of steel and concrete bridge over Dry creek at Lamberts has been awarded to D. E. Albers for $8691.

SAUSALITO—Contract for construction of topeka specification pavement on concrete base, with strip of vitrified brick on grades has been awarded to Clark & Henery Construction Company, Stockton, for $20,985.99. Price on the topeka pavement was 13.7c. per sq. ft., including grading.——Bids are being received by W. Z. Tiffany, city clerk, for construction of electrolier lighting system.——Following bids have been received for furnishing and laying 5670 ft. of 1-in. blank enameled conduit for electrolier system: Contra Costa Construction Company, 15.05c. per lin. ft.; Pacific Electric & Construction Company, 17c.; Pacific Gas & Electric Company, 28c.——Bids will probably be called for some time in August for improvement of a number of streets in residence districts. Oiled macadam will probably be used. Considerable sewer work will also be started before long, also a timber highway trestle and a concrete retaining wall. L. L. Hohl is town engineer.

SISSON—Bids will be received until 10 a.m., July 23, by town clerk for furnishing and laying 4511 lin. ft. of 6-in. woodstave pipe with tees, curves and branches, 6 gate valves, and 9 fire hydrants, all to be designed for 375-ft. head. Plans and specifications from town clerk or can be seen at office of **Western Engineering.**

SOUTH SAN FRANCISCO—Contract for harbor work for South San Francisco Land & Improvement Company, has been awarded to San Francisco Bridge Company, Nevada Bank Bdg., San Francisco, for $120,000.

STOCKTON—Clark & Henery Construction Company were low bidders at $4774.32 for wharf improvements, but as this was $900 above engineer's estimate, bids were taken under advisement.——Plans for fire-house on Rose street have been prepared by W. B. Thomas and plans for fire-house on South California street have been prepared by Ralph P. Morrell. Each building will cost $7000.——Contract for concrete street, gutter, curb, and bulkhead work has been awarded to Clark & Henery Construction Company for $5322.03.——Contract for construction of steel bridges across Old river and Middle river on Borden road has been awarded to Tibbetts-Pacific Company, San Francisco, for $140,449 and $139,567, respectively.——All bids for paving street west of Union mills were rejected because too high and new plans will be prepared and bids called for.——Island Transportation Company will build shipyard and terminal at Wood island, costing $50,000.——Ralph P. Morrell is preparing plans for building for Montezuma school.——Board of supervisors has accepted bids of California Delta Farms and of San Joaquin Ditching Company for supplying dredges for construction of grade for I. L. Borden road across Victoria island. California Delta Farm bid $55 per day for dredge with a 1-yd. bucket, and the San Joaquin Ditching Company bid $70 for one with a 1¼-yd. bucket.——Irey & McCleary were only bidders for improvement of road at New Hope Landing. Bid was taken under advisement.——Contract for alterations and additions to old Jefferson school has been awarded to French & Zink, for $9376.——Chirhardt & Hystedt were low bidders for construction of new Jefferson school at $9811, but as this was higher than the architect's estimate, the bid was taken under advisement.——Bonds for $550,000 for construction of system of storm and sanitary sewers have been voted.——Contract for street work, including curbs and gutters in Fair Oaks district, has been awarded to Guy T. Covault for $28,775.09.——Contract for improvement of Cherokee road has been awarded to Irey & McCleary, for $1584.

SUISUN—Bonds for $40,000 for construction of high school have been voted.

SUNNYVALE—City council will purchase 2329 lin. ft. of 4-in. water pipe.

SUSANVILLE—Bond issue of $100,000 for building new courthouse and county hospital have been voted.

TAFT—Bonds for $90,000 for construction of high school building have been voted.

TEHACHAPI—All bids for construction of lighting system exceeded the $8000 available and they were rejected.

TERRA BELLA—Supervisors have approved formation of irrigation district and will probably hear state engineer's report on July 6. S. E. Kieffer, Berkeley, is engineer for district.

TULARE—Tulare County Power Company has sold its system to Mt. Whitney Power & Electric Company for $610,000.

TURLOCK—Contract for paving West Main street has been awarded to Worswick Paving Company, Modesto, for 1½c. per sq. ft. for grading, 13½c. for paving, and 15c. for cement gutters.

VACAVILLE—Bonds for $12,000 for paving main street and for $6000 for purchase of automobile fire truck have been voted.

VENTURA—County surveyor has reported that the cost of replacing the damaged Casitas bridge over Ventura river will be $13,831, and that the cost of repairs to Saticoy bridge over Santa Clara river will be $48,138, not including 700 ft. of approach.

VISALIA—County will build bridge at Kingsburg over Kings river, costing $18,000. B. O. Lovelace is county surveyor.

WATTS—Contract for improving Fern street has been awarded to E. A. Clayton, 1321 Vanderbilt street, Bairdstown, for $5976.83.

WOODLAND—Contract for construction of grammar school has been awarded to Robert Trost, 26th and Howard streets, San Francisco, for $69,534.——City is in the market for 120,000-gal. steel tank on 80-ft. tower.——Question of voting bonds for water system is being considered. C. E. Arnold is city engineer.

YREKA—Board of supervisors has authorized construction of concrete bridge over Sacramento river at Dunsmuir on state highway. State highway commission will prepare plans and have charge of construction, and county will pay the cost.

OREGON

BAKER—Bids will be received until 2 p.m., July 9, by J. B. Messick, county judge, for construction of two bridges.——County court will receive bids until 2 p.m., July 8, for remodeling heating system of courthouse.

CORVALLIS—Southern Pacific Company will electrify line to Whiteson, 43 miles.

FREEWATER—Contract for erection of school building has been awarded to Seigel Eaton for $12,000.

GRANTS PASS—Contract for clearing 4½ miles of right-of-way on railroad between Wilderville and Hays Hill has been awarded to Albert Anderson & Company.

MEDFORD—Frank Clark is preparing plans for remodeling city hall. Estimated cost $8000.——Property owners in this district will form irrigation district. H. W. Bingham is interested.

PENDLETON—Parker & Banfield, 104 Grand avenue, Portland, were low bidders at $70,534 for construction of Eastern Oregon hospital.

PORTLAND—Department of public works has prepared plans for approach to interstate bridge, comprising 223-ft. reinforced concrete viaduct and 1160-ft. earth fill. Estimated cost $60,000.——Contract for construction of terminals at Pilot Rock Junction for Oregon-Washington Railroad & Navigation Company has been awarded to Twohy Bros., 219 East 60th street for $400,000.——Bids will be received until 11 a.m., July 15, at U. S. Engineers Office, for construction of two wooden barges.——Contracts for paving 66 miles of roads under county highway

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bond issue have been awarded as follows: Columbia River highway, Sections A, B, and C, bitulithic pavement, to Warren Construction Company, Journal Bdg., for $288,163.64, Section D, bitulithic pavement, to Pacific Bridge Company, Water and Salmon streets, for $155,332.78, Section E, brick on concrete base, to Boyajohn-Arnold Company, Panama Bdg., and Hans Pederson, for $22,921.66. Total length, 26 20 miles. Sandy road, bitulithic pavement, to Warren Construction Company, for $214,-849.17. Length 12.75 miles. Base Line road, bitulithic pavement, to Clark & Henery Construction Company, Sacramento, Cal., for $148,379.40. Length, 8.83 miles. Powell Valley road, bitulithic pavement to Oskar Huber, Electric Bdg., for $121,603.90. Length, 7.62 miles. Foster Road, concrete, to Montague-O'Reilly Company, Blake-McFall Bdg., for $75,610. Length, 4.34 miles. Slavin road, concrete, to Montague-O'Reilly Company, for $94,-043.36. Length, 4.34 miles. Canyon road, Section A, bitulithic pavement, to Boyajohn-Arnold Company and Hans Pederson, for $16,903.60; Section B, concrete, to Montague-O'Reilly Company, for $22,352. Length 1.67 miles. All bids for work on St. Helens road have been rejected.——Contract for furnishing 650,000 tons of rock for north jetty at mouth of Columbia river has been awarded to Columbia Contract Company, Water and Main streets, for $1 per ton.——Bids will be received until 11 a.m., July 12, at U. S. Engineer office, 802 Couch Bdg., for enlarging and repairing the receiving-wharves and tramways and extending north and south jetties at mouth of Siuslaw river. Contract for construction of $35,000 warehouse for Mason, Ehrman Company has been awarded to J. P. Taylor, McLeay Bdg.——Oregon-Washington Railroad & Navigation Company will erect 100-ton hydraulic press at Tekoa. Work will be commenced on Echo cut-off. Estimated cost $250,000. ——Proposed purchase of 5000 water meters and establishment of municipal garbage plant were both defeated at election.

ROSEBURG—Bonds for $300,000 for building railroad have been voted. This insures construction of railroad in conjunction with Kendall Bros., of Pittsburg, Pa. Kendall Bros. will also build sawmill. Total cost of project will be about $1,250,000.

SALEM—Contract for construction of 30,000 lin. ft. of drain-ditch in district No. 1 has been awarded to L. W. Atcheson for $1.41½ per rod.——Snook & Travers were low bidders at $20,-450 for construction of building for McKinley school.

SEASIDE—Citizens of Seaside, Astoria, and Gearhart will build road between Astoria and Seaside. Estimated cost is $25,000. J. S. Dellinger is interested.

ST. HELENS—Contract for construction of a section of St. Helens-Pittsburg highway has been awarded to A. H. Tarbell.

SUMPTER—A. H. Brown is preparing to start gold-dredging operations.

VALE—Oregon-Washington Railroad & Navigation Company will extend line to Riverside, thirty miles.

WASHINGTON

ABERDEEN—Watson & Vernon are preparing plans for cottage for girls' training school near Grand Mound. Estimated cost, $45,000.

CASTLE ROCK—Contract for construction of paving in district No. 5, has been awarded to Albers & Son, Chehalis.

CATHLAMET—Bids will be received until 1 p.m., July 6, by B. Heron, county auditor, for clearing, grubbing, and grading state road No. 19.

CHEHALIS—Hurd & DeCamp, Spokane, were low bidders for construction of sewer system at $17,575.20.——City commissioners have decided to pave National avenue.

COLFAX—Council has voted to replace present wood-stave supply-main with 12-in. steel pipe, laying same as money becomes available. About $5000 will be spent this year.——Contract for construction of Andy Horton road has been awarded to W. G. Mulligan & Co., Pullman, for $7658.——County commissioners will receive bids until July 6 for construction of four concrete bridges, spans varying from 25 to 60 feet.

COLTON—William Smith, Pullman, is preparing plans for high school building. Estimated cost, $15,000.

COLVILLE—Stevens County Power & Light Company will build new dam and power station. H. R. Williams is manager.

COSGROVE—Contract for construction of arsenal at American Lake has been awarded to Far West-Clay Construction Company, Bankers Trust Bdg., Tacoma, for $17,320.

CUSTER—Contract for construction of 4½ miles of drain ditch has been awarded to Charles Lind, Bellingham, for $10,644.

DAYTON—Contract for grading and macadamizing Johnson Hollow road has been awarded to Cascade Construction Company, Mutual Life Bdg., Seattle, for $13,940.

DOTY—Doty Lumber & Shingle Company will build five-mile logging railroad. W. D. Bunker is interested.

ELLENSBURG—Contract for construction of municipal light plant has been awarded to W. A. Kraner & Company, Chamber of Commerce Bdg., Portland, Oregon, for $59,000.

ELMA—Contract for construction of asphalt pavement has been awarded to Washington Paving Company, Savage-Scofield Bdg., Tacoma, for $48,000.

EVERETT—Contract for construction of post-office has been awarded to Hendrickson & Company, 311 Alaska Bdg., Seattle, for $111,319.——Contract for construction of permanent highway No. 16 has been awarded to Reinseth Bros., Arlington, for $3445.——Contract for asphalt pavement on Cedar street has been awarded to Washington Paving Company, Savage-Scofield Bdg., Tacoma.——Contract for construction of permanent highway No. 14 has been awarded to Atlas Construction Company, for $14,260.——Election has been set for August 17 to vote on bonds for $600,000 for construction of dam and pipe-line, and for $1,100,000 for purchase of plant of present water company.—— Contract for construction of permanent highway No. 15 has been awarded to Bancroft & Morgan for $7442.——Contract for construction of ditches in drainage district No. 4, has been awarded to George P. Wright, Provident Bdg., Tacoma, for $33,828.70.

FALLS CITY—J. H. Baer, Seattle, has been awarded contract for construction of school building at $26,375.

FROMBERG—Bids are being received by city clerk for construction of water system. Estimated cost, $17,500.

HOQUIAM—City engineer J. H. Neef is preparing plans for 22 blocks of paving, costing $106,500.

KALAMA—Contract for improvement of permanent highway No. 1A has been awarded to N. P. Willis, Hoquiam, for $10,490.

KELSO—Contract for construction of 6860 lin. ft. of concrete road near Woodland has been awarded to Jeffrey & Bufton, Failing Bdg., Portland, for $10,440.

KEYPORT—Contract for construction of storehouse and repair-shop at torpedo station has been awarded to Martin & Dugan, Seattle, for $36,513.

MONTESANO—Contract for construction of three bridges has been awarded to Coast Bridge Company, Railway Exchange Bdg., Portland, for $16,400.

MT. VERNON—Contract for construction of Montborne- McMurray road has been awarded to Quigg Construction Company, 1127 L. C. Smith Bdg., Seattle, for $11,285.90.——Bids will be received until July 7 by W. V. Alexander, county auditor, for construction of 2½ miles of two-course concrete pavement on permanent highway No. 2A. Plans from A. L. Strong, county engineer.

NEWPORT—Bids will be received until 10 a.m., July 6, for grading and graveling two miles of permanent highway 7A. Estimated cost, $20,000.——Contract for construction of 1½ miles of permanent highway No. 5 has been awarded to Langille & Connor for $3250.

NORTH YAKIMA—Contract for furnishing clay pipe for drainage district No. 4 and 24 has been awarded to Fosseen & Co. for $3505.54. Contract for laying this pipe has been awarded to G. L. Klein for $5395.59.

OLYMPIA—Contract for construction of one mile of highway in Kittitas county has been awarded to Quigg Construction Company, L. C. Smith Bdg., Seattle, for $3381.25.——Contract for construction of 7½ miles of highway from Vancouver to La Center has been awarded to General Construction Company, Mallon and Post streets, Spokane, for $25,035.35.——Following contracts have been awarded for state highway work: from Nisqually to Lacey, to L. H. Goerig, 1027 Bellevue court, Seattle, for $16,377.80, from Toledo southerly, to Andrew & Honer, Portland, for $18,748.10, approaches to Mashell bridge in Pierce county, to Kendle & Appler, Eatonville, for $17,355; for 9½ miles of rock and earth excavation between Rockland and Creston to the Mohr Construction Company, Waterville, for $41,-479.30; for four miles between Cashup and Steptoe, to General Construction Company, Mallon and Post streets, Spokane, for $11,955.75; for 5½ miles south of Colfax to H. L. Wilson Company, Walla Walla, for $19,279.55 ——Bids will be received until 2 p.m., July 12, by W. R. Roy, state highway commissioner, for construction of 15 miles of highway between Mud Bay and McCleary. Estimated cost, $38,000.——Contract for construction of highway from Kalama north has been awarded to Hendricks & Ward, Centralia, for $6601, and for highway between Woodland and La Center to Porter & Conley, Kalama, for $6593.40.—— Contract for construction of paving west of Main street has been awarded to Independent Asphalt Paving Company, Northern Bank Bdg., Seattle, for $9920.70.

PORT ANGELES—Contract for construction of trunk sewer on Francis street has been awarded to H. A. Cotton, for $38,404.

PORT ORCHARD—Contract for construction of highways No. 2 and 3 has been awarded to A. E. Schold for $6494 and $4290, respectively.

PORT TOWNSEND—City council is receiving bids for hydraulicking bluff at west end of Water street. Estimated cost, $17,230. W. J. Sadler is city engineer.——Contract for construction of Jefferson-Clallam highway has been awarded to Ferch & Gass, 201 White Bdg., Seattle, for $7251.

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PRESCOTT—Contract for additions to water system has been awarded to George Schreiver, Walla Walla, for $8449.

PULLMAN—Franchise for gas system to cost $75,000 has been awarded to L. H. Burnett, United States Gas Company, Seattle.

REPUBLIC—West Virginia Mining Company will erect 200-hp. compressor, Diesel engine, and electric hoist.

SEATTLE—Contract for furnishing electric hoist for shear-leg derrick for port commission has been awarded to Washington Construction Company, Northern Bank Bdg.——Contract for street improvements on 30th avenue has been awarded to A. Arnoldo & Company, 904 Bailey street, for $3269.15.——Contract for paving 9th avenue has been awarded to P. J. McHugh, Third and Mercer streets, for $19,360.40.——Contract for construction of Redmond-Issaquah road has been awarded to Horrocks Construction Company, 911 Lowman Bdg., for $55,099.——Contract for construction of Greenwood avenue extension has been awarded to Dan McGarry, 911, 19th avenue, north, for $38,894.49.——Contract for construction of F. B. Holt road has been awarded to Otto Strauch, 3424 North 24th street, Tacoma, for $10,050.——T. M. Ryan & Son, 30th and Jackson streets, were low bidders at $25,081, for construction of juvenile detention home.——Contract for construction of Vashon Island road, six miles long, has been awarded to Jesse T. Mills, Olympia, for $28,539.——Board of public works will receive bids until 10 a.m., July 23, for construction of two bascule bridges on Lake Washington canal. Plans from C. B. Bagley, secretary, upon deposit of $15. Separate bids may be submitted for concrete substructure, steel superstructure, operating machinery, or for the entire work. Total estimated cost, $830,000.——Contract for construction of Landsburg bridge has been awarded to Fleines & Dahl, 1350 East Fir street, for $6134.30.——Contract for paving 10th avenue has been awarded to F. McLellan, Globe block, for $204,687.01.——Contract for paving 8th avenue has been awarded to Jahn Contracting Company, Pioneer Bdg., for $29,-530.71, using sandstone on 4-in. base.——Contract for construction of 400-ft. pile dock at Richmond Beach for Shell Oil Co., has been awarded to J. A. McEachern Company, Inc., Colman Bdg.——Board of works will probably soon ask for bids for sealing Cedar River dam. Estimated cost, $300,000.

SPOKANE—Contract for furnishing 2,000,000 brick for power plant at Thompson Falls, Montana, has been awarded to Idaho Lime Company, 1310 Ide street.——Contract for construction of $40,000 four-story reinforced concrete warehouse for W.P.Fuller & Company, has been awarded to Colonial Building Company.——Contract for construction of warrenite and asphaltic macadam pavement from Rockford to Waverly, 11½ miles, has been awarded to Ambrose-Birdsall Company, Portland, Oregon, for $165,500.——Carlson Chindahl Company, Fernwell Bdg., were low bidders at $111,000 for construction of 11½ miles of Palouse highway.——Contract for sewer changes on Sprague avenue and on Division street has been sublet to Dixon & Oliver for $25,500.

TACOMA—Contract for bitulithic paving on part of Steilacoom boulevard has been awarded to Washington Paving Company, Savage-Scofield Bdg., for $25,260.——Contract for sidewalks on several streets has been awarded to M. P. Madsen, 4801 North 9th street, for $3998.——Contract for construction of Tahoma Creek bridge in Mt. Rainier National park has been awarded to McHugh & Creelman, 603 Provident Bdg.——Sperry Flour Company will spend $65,000 on additions to mill. John D. Armstrong is local manager.——Heath & Gove, National Realty Bdg., are preparing plans for hospital for insane at Sedro-Wooley. Estimated cost is $158,000.——Sunset Telephone & Telegraph Company will spend $13,500 on extension of lines.——Contract for construction of steel bridge at South Prairie has been awarded to Omaha Structural Steel Works, 605 Bankers' Trust Bdg., for $2998.——Chicago, Milwaukee & St. Paul railway will build $400,000 passenger station at 25th and East A streets.——All bids for grading South 38th street and for wrecking bridge between G and Park streets were rejected because too high and new plans will be prepared by city engineer Raleigh.

TUMWATER—Contract for construction of concrete bridge across Deschutes river has been awarded to Chas. G. Huber, Central Bdg., Seattle, for $13,789.

VANCOUVER—County commissioners will receive bids until July 3 for construction of 21,000 sq. ft. of macadam on three permanent highways. Estimated cost, $35,000.——D. Nichols is preparing plans for building for state school for blind. Estimated cost, $75,000.

WALLA WALLA—Contract for macadamizing three miles of road to Waitsburg has been awarded to Cascade Construction Company, Mutual Life Bdg., Seattle, for $16,948.——Contract for construction of reinforced concrete bridges across Mill creek has been awarded to H. C. Malott, 6526 17th street for $1565.——Contract for construction of courthouse has been awarded to J. B. Sweatt Company, Spokane, for $157,000.

Engineering Societies and Conventions

IDAHO SOCIETY OF ENGINEERS. Ira F. Schaffner, secretary, Boise.

Los Angeles Section of AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Ford W. Harris, secretary, 1029 Higgins building.

Los Angeles Section of AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Edward Woodbury, secretary, 255 East 3rd street.

OREGON SOCIETY OF ENGINEERS. Orrin E. Stanley, secretary, room 409, City Hall.

Portland Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. Charles McGonigle, president, care Western Sheet Metal Works.

Portland Section, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Paul Lebenbaum, secretary, 45 Union Depot.

San Francisco Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. E. T. Thurston, Jr., secretary, Mechanics Institute building.

San Francisco Section of AMERICAN SOCIETY OF MECHANICAL ENGINEERS. F. W. Gay, secretary, care J. G. White & Co., Alaska Commercial building.

San Francisco Section of AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. A. G. Jones, secretary, 811 Rialto building.

Southern California Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. W. K. Barnard, secretary, 701 Central building, Los Angeles.

Coming Conventions

AMERICAN ELECTROCHEMICAL SOCIETY, San Francisco, September 16-18. J. W. Richards, secretary, South Bethlehem, Pennsylvania.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, San Francisco, August 25-28. J. C. Olsen, secretary, Cooper Union, New York.

AMERICAN INSTITUTE OF MINING ENGINEERS, San Francisco, September 16-18. Bradley Stoughton, secretary, 29 West 39th street, New York.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, San Francisco, September 16-18. F. L. Hutchinson, secretary, 33 West 29th street, New York.

AMERICAN MINING CONGRESS, San Francisco, September 20-25. J. F. Callbreath, secretary, Washington, D. C.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, San Francisco, September 16-17. Calvin W. Rice, secretary, 29 West 39th street, New York.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, San Francisco, September 16-18. J. J. Blackmore, secretary, 29 West 39th street, New York.

AMERICAN SOCIETY OF CIVIL ENGINEERS, San Francisco, September 16-19. Charles Warren Hunt, secretary, 220 West 57th street, New York.

INTERNATIONAL ENGINEERING CONGRESS, San Francisco, September 20-25. W. A. Cattell, secretary, Foxcroft building, San Francisco.

INTERNATIONAL IRRIGATION CONGRESS, Stockton, September 13-14; Fresno, September 15-16; Sacramento, September 17-18; San Francisco, September 20. Arthur Hooker, secretary, Sacramento, during July, Stockton, during August and September.

LEAGUE OF CALIFORNIA MUNICIPALITIES, Oakland, September 7-11. H. A. Mason and W. J. Locke, secretaries, Pacific building, San Francisco.

PACIFIC HIGHWAY ASSOCIATION OF NORTH AMERICA, San Francisco, August 11 and 12. H. L. Bowlby, executive officer, 510 Chamber of Commerce building, Portland, Oregon.

PAN-AMERICAN ROAD CONGRESS, Oakland and San Francisco,

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September 13-18. Charles P. Light, secretary, Colorado building, Washington, D. C.

Personal

T. D. KILKENNY has been appointed city engineer of Vallejo, California.

G. H. YOCCO has been appointed city engineer of Los Gatos, California.

W. W. KEITH has been appointed harbor manager at Oakland, California.

R. H. THOMPSON has opened offices as a consulting civil engineer at 520 Alaska building, Seattle.

CHESTER L. HOVEY, of San Francisco, has been appointed receiver of the Boca & Loyalton railroad.

BERTRAM D. DEAN has opened offices as a consulting civil engineer at 2110 Smith building, Seattle.

HORACE E. SMITH, of Brewster, Washington, has been appointed county engineer of Okanogan county.

E. F. AYRES has been appointed resident engineer for the Oregon State Highway Commission, with headquarters at Sherwood.

CHARLES EVAN FOWLER, consulting engineer of Seattle, was in San Francisco for several days in connection with professional work.

F. N. BINGHAM, for some time superintendent of the municipal asphalt plant of Spokane, Washington, has resigned to enter the contracting field.

CLARENCE P. DAY and SEYMOUR H. PHELAN have opened offices for general engineering practice in the First National Bank building, Santa Barbara, California.

Control of state highway work in Washington was placed in the hands of E. I. CANTINE, and his department made independent of that of JOHN H. LEWIS, state engineer.

WILLIAM F. FOWLER has been appointed receiver for the Sacramento Valley Irrigation Company and the Sacramento West Side Canal.

N. C. RAY, of Merced, California, has been appointed senior civil engineer for the Pacific district in connection with the railroad valuation for the Interstate Commerce Commission.

ROSWELL H. JOHNSON and L. G. HUNTLEY presented a paper at a meeting of the Engineer's Society of Western Pennsylvania, entitled 'The Influence of the Cushing Pool in the Oil Industry.'

G. H. BYERS, for several years connected with the Chicago, Milwaukee & St. Paul railroad, has been appointed assistant engineer in connection with the railroad valuation now being made by the Interstate Commerce Commission.

GEORGE S. WATERMAN and H. E. VOGEL, of Fresno, and HARRY WINNES, of Reedley, have been named as highway commissioners of Fresno county, California, to report on the proposed $3,000,000 bond-issue for a county highway system.

SYDNEY B. WILLIAMSON, chief of construction of the U. S. Reclamation Service, has been placed in charge of the executive offices of the Service at Denver, Colorado. Control of all the reclamation projects will be centred at that office.

L. JORGENSEN, who has been associated with F. G. Baum & Co. for the past eight years, has opened offices at 1405 Chronicle building, San Francisco, where he will engage in general electric and hydraulic engineering practice, specializing in the design of arch-dams.

HEIKE KAMERLINGH ONNES has been awarded the Franklin Medal, the highest honor of the Franklin Institute of Philadelphia, for his "long-continued and indefatigable labors in low-temperature research which have enriched physical science, not only with a great number of new methods and ingenious devices, but also with achievements and discoveries of the first magnitude."

At the convention of the National Electric Light Association, held at San Francisco, June 7-11, the following officers were elected for the ensuing year: president, E. W. LLOYD, Chicago; vice-presidents, H. A. WAGNER, Baltimore, W. F. WELLS, Brooklyn, R. H. BALLARD, Los Angeles, and R. S. ORR, Pittsburg; treasurer, W. H. ATKINS, Boston; insurance expert, W. H. BLOOD, JR., Boston; secretary, T. C. MARTIN, New York; assistant secretary and treasurer, HARRIET BILLINGS, New York; new members of the executive committee, J. E. DAVIDSON, Portland, Oregon; H. C. ABELL, New York; H. C. BRADLEE, Boston; and R. F. PACK, Minneapolis.

Obituary

FRANK AMHERST BOWEN, vice-president of the Concannon Engineering Co., of San Francisco, died June 22 at his home in Oakland.

O. W. JASPER, SR., for many years engaged in engineering work for several railroads in California, died June 21, at his home in Berkeley, California.

Commercial Paragraphs

The Panama-Pacific Exposition has awarded to the STANDARD OIL CO. a gold medal for conservation of natural resources and a special gold medal of honor for its works and policies.

John S. Martin, of the PACIFIC CEMENT GUN CO., has opened an office at 332 Pine street, where he will handle the steam and other engineering supplies of the W. E. Mushet Company.

The BROWN HOISTING MACHINERY CO. has sold a portable gasoline clam-shell dredge to the United States Reclamation Service for use in maintenance work on the Minidoka project, Idaho.

The HOLT MANUFACTURING CO., of Stockton, Cal., has been awarded two grand prizes, five medals of honor, and two gold medals for its exhibit of 'caterpillar' machinery at the Panama-Pacific Exposition.

The HAGAR PORTLAND CEMENT CO., promoted by Edward M. Hagar, has been incorporated for $20,000,000. The headquarters will be at 208 La Salle street, Chicago. The annual output of the various plants included in the company is stated to be 14,000,000 barrels.

Joseph Battles has been appointed district sales manager for the TERRY STEAM TURBINE CO., his territory covering the States of New Mexico, Colorado, Wyoming, and western Nebraska. He will have headquarters at 326 National Bank building, Denver, Colorado.

BUSCH-SULZER DIESEL engine day at the Panama-Pacific Exposition on June 21. Charles V. Vogelsang, representing the Exposition management, presented a bronze medal of honor to W. S. Heger, representing the Busch-Sulzer Bros.-Diesel Engine Co., and an appropriate program was rendered.

Catalogues Received

COOLING WATER. Bulletin 40 of the Spray Manufacturing Co., 201 Devonshire street, Boston, Massachusetts. Describes the systems for cooling water constructed by the company, in which the water is converted into fine spray. P. 8. Illustrated.

WAGON AND TRUCK LOADERS. The Link-Belt Co., Philadelphia, Chicago, Indianapolis. Describes the portable loaders manufactured by the company for handling coal, earth, crushed rock, and similar material. They work on the bucket-elevator principle. P. 48. Illustrated.

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